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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN, THE NATIONAL IRONFOUNDING EMPLOYERS' FEDERATION, THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

JANUARY 9.

Institute of Marine Engineers:—Meeting in London at 6 p.m. "Modern Steels for Marine Engineering," Paper by T. H. Burnham.

Institute of Metals (North-East Coast Local Section):—Meeting at Armstrong College, Newcastle, at 7.30 p.m. "Welding," Paper by a representative of Messrs. Metropolitan-Vickers Electrical Company, Limited.

JANUARY 11.

Institute of Metals (London Local Section):—Meeting at 83, Pall Mall, London, at 7.30 p.m. "Beryllium and its Alloys," Paper by H. A. Sloman.

JANUARY 12.

Institute of Metals (Sheffield Local Section):—Meeting at the University, Sheffield, at 7.30 p.m. "Protection from Corrosion of Aluminium and its Alloys," Paper by N. D. Pullen.

Institute of British Foundrymen.

JANUARY 9.

Lancashire Branch (Burnley Section):—Meeting at 7.15 p.m. "Blast-Furnace Practice and Notes on the Making of Irons." (Lecturer to be announced later.)

JANUARY 10.

London Branch:—Meeting at the Northampton Polytechnic Institute, St. John's Street, Clerkenwell, at 8 p.m. Joint meeting with the Electro Depositors' Technical Society.

Lancashire Branch (Preston Section):—Meeting at 7.30 p.m. "Mechanisation in the Foundry," Paper by G. E. France. (Illustrated by cinematograph film.)

JANUARY 12.

Middlesbrough Branch:—Meeting at the Technical Institute, Middlesbrough, at 7.45 p.m. "A General Review of the Foundry Trade To-day," Paper by Major R. Miles.

JANUARY 13.

Lancashire Branch (Burnley Section):—Annual social.

West Riding of Yorkshire Branch:—Annual dinner.

Scottish Branch:—Meeting in Glasgow, at 4 p.m. "Moulding and Casting Hydraulic Valves," Paper by R. D. Lawrie.

Moulding Machine Production.

It is somewhat surprising to learn from conversations with practical foundrymen that they assert that the moulding machine suppliers overstate the production obtainable from their machines. We have on many occasions timed the production of moulds, and the results disclosed are such that actual moulding times are relatively insignificant. After installation, however, total moulding time bears but little relation to the efficiency of the moulding machine, as the major portion of the total time is consumed in handling sands, boxes and carrying. It is obvious that unless full conditions existing in the customer's works are known, the estimated production of a moulding machine is a pure gamble. The production attained by the Midland Manufacturing Company from their moulding machines is greater than would be obtained from a foundry where the sand supply is not continuous and time is wasted in carrying moulds.

One of the greatest time-consuming factors is related to whether a facing sand is deemed necessary. If one sand be sufficient, much energy is saved, though cases exist where two overhead hoppers are provided for the supply of both facing and backing sands. It is becoming increasingly popular in non-repetition foundries for the moulding machines to be supplied with overhead hoppers filled by either "throwing" the moulding sand up a chute or by a bucket elevator. The hoppers in such cases should have two of their sides definitely vertical and the other two tapered. Before putting into use, they should be blackleaded on the inside, and in no case should hammering be allowed, as the sand can and will build up on a dent.

For most moulding-machine jobs, efficiency is not really attained until adequate provision is made for getting the moulds away from the machine and the moulding boxes to it, and the minimum to be expected is a length of gravity conveyor, though a power-driven plate conveyor controlled by a push-button at the moulding machine is a practical and not too expensive a proposition for increasing the efficiency of a moulding plant, as it serves the dual purpose of bringing up the empty boxes and taking away the finished mould, and allows of an accumulation of work to be collected ready for teeming when the movement is again of value both for teeming and knocking out at a central point. This method was recently detailed by Mr. R. G. Russell, of Australia, where such provision was made for a single moulding machine.

Taking the above into consideration, it will be seen that comparison of speeds of moulding machines can only be on a theoretical basis of the time taken for the various motions necessary for the production of a mould, or, in other words, ideal conditions must be assumed.

What is a Metallurgist?

We occasionally notice with some surprise the extent to which our advertisements of posts vacant, calling in definite terms for a man of particular training and experience, are answered by those who cannot really lay claim to either. No employer, we think, would read otherwise than sympathetically an application from a metallurgist who wished to become a foundry manager, or from a manager who wished to become a metallurgist, although in our experience such translations are more common inside one works than between one works and another. However, we ask the question as to what defines a metallurgist because such men are frequently called for, and the profession is not a preserve of men of particular training or experience. Those societies representing the legal and medical professions have power to prescribe the conditions under which one who aspires to join them may do so. We can, however, say to some extent what a metallurgist is not. He is definitely, in these days, a man who is more than a moulder or a coremaker, or even a chargehand or foreman. Mere contact with the making of mixtures and the purchase of raw material is not enough; neither, incidentally, is mere membership of one of the national bodies.

It will be acknowledged that a metallurgist is one who has had a university or technical college training in and preferably taken a degree in metallurgy, or in engineering or chemistry, in courses which have lectures and laboratory

XUM

work in metallurgy. Alternatively, the Associateship courses of such a body as the University of Sheffield or the Manchester College of Technology, would be regarded as high qualifications, both of which can be taken as evening courses. The external London degree can also be got entirely by evening study. The Associateship of the Institute of Chemistry, with the metallurgical sections taken, is also a qualifying certificate, as may be the Associate Membership of one of the chartered institutions like the Mechanicals or Electricals. Next to these may be regarded the National Certificate examination of the Mechanicals with the Foundry endorsement. The City and Guilds Certificate in Foundry Science and Practice is essentially a craftsman's certificate which may be taken in their stride by young metallurgists in the making. Practice and experience will help to make the man turn the paper qualification into a reality.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Theory and Practice.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The leader in your issue of December 28, 1933, raises an interesting issue which the writer has for years been putting before authorities, namely, that for students to be successful, they must be thoroughly trained in practice as well as theory, and that before "national certificates," "degrees" and other certificates are issued, the candidate should have worked as a journeyman.

Even Sheffield University, with its Foundry Degree Scheme, is still prejudiced against the man trained in industry, and is making no provision for the external student. Can they expect the practical man, with his wealth of knowledge gained after many years' contact with the problems, to come forward and help them with information necessary if the course is to be successful industrially?

Your remarks about the "practical man" often being a theorist are true in every sense of the word, and if I want information, I find that I can always obtain sound advice from the practical man, but only a wealth of figures on paper if the journey is to the "technical expert."

I do not think the "practical man" actually draws a line between practice and theory; it is usually foresight gained from experience, and the case is generally due to his seeing that the cost of the product must rise if the idea is carried out. It has to be remembered that, while often cost in the factory due to actual production can be decreased either by cheaper methods, standardised procedure or mass production, the ultimate cost is more often increased due to the heavy administration and depreciation charges involved. Many are the firms where the overheads are out of all proportion to the product cost.

Further, it is extremely problematical whether we are turning out better castings than 15 years ago, and although we hear on all sides of what wonderful things science has done, including the production of nickel iron, testing and controlling sands, alloy steels, nitrogen hardening, etc., it appears to me that we should do well to read some of the older works, as, for example, Cavendish Works, Gresmans and Gmelin.

What industry requires is not Paper reading, but a few good practical leaders capable of saying whether the work is being done in the most economical way, and, if not, given the authority to provide the foundry with the means to do it practically, and one of the essentials is to arrange that all designs are submitted to the foundry, pattern-shop and machine-shop superintendents for approval before being proceeded with. This suggestion will meet with opposition, I know, but in cases where this is done I have seen real production economically maintained. The reason is apparent, if examined, and it is seen that the superintendents share the responsibility for the ultimate result, and in consequence can plan operations before design is completed and not after, as is the general case now.

In all the broil of the talk of science, "national certificates," "degrees," City and Guilds, Lancashire Union, etc., we are losing sight of the important fact that castings and machines have never yet, and never will, be produced with certificate knowledge; there must always be a supply of patternmakers, foundrymen and toolmakers, and these must be given their rightful status and pay if industry is to keep its head above water. Failure to keep the supply of these essentials means that our works can shut up.

If industry is to progress, we have to find better leaders than we have had for the past ten years. The leaders must be works-trained men with strong personalities, sound judgment, energy, enthusiasm, and, above all, the ability to use their qualifications aright.

In conclusion, may I suggest to your readers that the time is ripe for an Institution of Engineering Craftsmen, whose aim should be to study the problems arising, and to form a register of craftsmen. I shall be glad to hear from any interested.—Yours, etc.,

CHAS. NORTHEY, A.M.I.Prod.E., M.I.B.F.
74, Nathans Road,
North Wembley, Middlesex.
December 29, 1933.

Treatment for Wood Screws.—A treatment for wood screws which greatly improves their driving properties has been developed in the United States. It is designated as "Speedising" and is obtained by a chemical process. Tests have shown that in cases where untreated screws cannot be driven or only with considerable difficulty, the treated screws are driven with comparative ease. It is claimed that to drive a treated screw by a portable electric screw driver requires only about one-third the power necessary for a plain wood screw of equal size under identical conditions, this fact having been borne out by careful tests. The manufacturer states that with the use of the treated screws, the need for resorting to soaping, waxing, greasing or otherwise lubricating screws, before driving is made unnecessary. The treatment can be applied to any screw or metal product.—"Steel."

Charitable Contributions.—Many Scottish firms have made their annual distribution to infirmaries and other charitable institutions, as follow:—Messrs. Cruikshank & Company, Limited, Denny Iron Works, Denny, £124 19s. 7d.; Messrs. Drysdale & Company, Limited, Bon Accord Works, Yoker, Glasgow, £181; The Mirrlees Watson Company, Limited, Glasgow (Foundry and Engineering Departments), £350 9s.; North-West Rivet, Bolt & Nut Factory, Limited, Airdrie, £58; The Scottish Tube Company, Limited, Govan Works, £47; Blairs, Limited, Govan, Glasgow, £158; Acme Wringers, Limited, Glasgow, £125; Smith & McLean, Limited, Gartcosh Steel Works, Glasgow, Milnwood and Port Glasgow Works, £500; Messrs. A. F. Craig & Company, Limited, Caledonia Foundry, Paisley, £82 10s.; The Summerlee Iron Company, Limited, £1,443 16s. 3d.; Messrs. Archibald Baird & Company, Limited, Clyde Steel & Engineering Works, Hamilton, £95; Glencairn Metals, Limited, Flemington, Motherwell, £45; Blantyre Engineering Company, Limited, Blantyre, Hamilton, £65; Coltness Iron Company, Limited, £3,877 4s.; The Clyde Structural Steel Company, Limited, Glasgow, £32; Messrs. Jones & Campbell, Limited, Torwood Foundry, Larbet, £287 6s. 8d.; Alexander Stephens & Sons, Limited, Linthouse, Glasgow, £251; The Springfield Steel Company, Limited, Glasgow, £52; Messrs. David Rowan & Company, Limited, Glasgow, £207; Lancefield Foundry Company, Limited, Glasgow, £18; The Scottish Iron & Steel Company, Limited, £375; The Singer Manufacturing Company, Limited, Kilbowie, £566; Shaw Glasgow, Limited, Maryhill Iron Works, Glasgow, £193 11s.

Random Shots.

Some of the patent food and medicine manufacturers have lately set out to warn us against the perils of starvation. Not the good old-fashioned belt-tightening variety, oh! dear no, but starvation in modern, scientific forms. If, when you arrive home in the evening and suggest to your wife that the two of you go along to a bridge party, a theatre, the local Branch's whist-drive or to the Town Hall to hear the Rev. Wollyhay's address on "Fifty Years on the Congo," your wife collapses and says "I couldn't face it," you now know that she is suffering from starvation. It may be night starvation or even iron starvation. The latter, incidentally, is a common complaint in the foundry industry. "Is your stockyard suffering from iron starvation?" is how a circular letter sent out by an enterprising pig-iron merchant opens. His infallible cure is a ton of special XXX-grade pig-iron, to be taken daily, or even more frequently if required.

* * *

BAGDAD BY 'BUS.

Riding on a camel in the desert (as the popular song has it) may be a romantic way of travelling, but those who are not accustomed to it are inclined to get the hump. Very soon it will be possible, so "Marksman" reads, to travel all the way from Damascus to Bagdad, via the Syrian Desert, by 'bus. This 'bus, of American build, seats 35 persons, will have three drivers, has a refrigerator containing 500 lbs. of ice, a 90-gall. water-supply tank, a 250-gall. fuel tank for the Diesel engine, telephone system, reclining chairs, baggage compartments, cooking equipment and an all-chrome-nickel-steel body. For further particulars as to fares, service, etc., apply to Traffic Manager, Syrian Desert.

* * *

Have you heard about the Hatton Garden diamond merchant who decided one day to fly across to Amsterdam? He was on the point of leaving his office for Croydon when his night-watchman accosted him and implored him not to make the trip by 'plane. "There'll be a crash, I know there'll be a crash, sir," he said, with such conviction that the merchant was deeply impressed.

"You quite alarm me," he said. "How is it you feel so positively that the aeroplane will meet with disaster?"

"Well, sir, believe it or not, I'm psychic, and last night I dreamed the aeroplane you meant to go by would have an accident. So don't travel on it, sir—I'm sure it will."

The diamond merchant, thoroughly scared, went by boat, and whilst in Amsterdam heard that the aeroplane had crashed. When he returned he called for the night-watchman and gave him a cheque for £25 and the "sack."

* * *

A real-estate salesman in western Texas had given to his prospective client a glowing description of the opportunities of that part of the country. He concluded by declaiming, with a fervour that Babbit, realtor, himself would have admired: "All that west Texas needs, to become the garden spot of the world, is good people and water."

"Huh!" replied the prospect. "That's all Hell needs."

MARKSMAN.

Vitreous Enamels and Colours as Used for Cast Iron and Steel.*

By A. England, M.Sc. (Mch.), (Consulting Chemist to the Blythe Colour Works).

Early enamelling was devised for ornamentation, and it is beyond our subject to delve into its antiquity; suffice it to say that it was largely practised during the 15th and 16th centuries, mainly in France and Italy. The material used was merely a soft glass, usually coloured with raw mineral earths, the chief constituents of which were cobalt, iron, copper and manganese, generally in the form of oxides.

There seems to be no definite history of the application of enamels to articles of everyday use, although the Germans appear to have been the first to put enamelling into practice for such, and with their scientific methods developed the formulæ and modes of application up to approximately the beginning of this century. The first factory of which the author has any note in this country is "The Patent Enamel" at Selly Oak, Birmingham, which factory is still in existence under the management of Mr. William Noake. The earliest enamels were silicates of lead and borax melted together to form a glass and in many ways were of a similar nature to the celebrated Stourbridge flint glass, but necessarily softer. The composition of the latter is approximately three parts of Fontainebleau sand (silica), two of red lead (oxide of lead) and one of carbonate potash by weight. The introduction of borax served to soften this to its use for vitreous enamels.

An old formula for vitreous enamel of this nature was two parts of silica, six of red lead and two of borax. After this mixture had been melted and run into water, technically known as "fritted," the frit was ground to a powder and was then ready for use. The cleaned metal article (a description of the cleaning processes will be given later) was then smeared with a viscous solution of silicate of soda and heated in a muffle. When the correct temperature was reached the article was withdrawn and the powdered enamel sprinkled on, the heat from the iron causing the enamel to flow and also to adhere.

Modern Enamelling.

Modern enamelling is of two kinds: (1) the dry process and (2) the wet process, but before going further it is necessary to explain the constitution of the present-day enamel, and here, even in this twentieth century, there is the secrecy and mystery reminiscent of the days when our forefathers sought the Elixir of Life and the Philosopher's Stone. The author is often approached by people in enamelling factories and asked most fabulous prices for so-called "secret recipes." Suffice it to say that although not much scientific research (except of a private nature) is carried on in the British Isles, America and Germany have published researches which have been carried out by state-aided institutions. Unfortunately, it has often happened that "gentlemen" from these two countries have played on the credulity of the British manufacturer, who has sometimes bought formulæ (or finished enamels) which he might have had for the asking.

In the building-up of an enamel formula there are three essentials to be considered: (1) the melting temperature of the finished enamel; (2) the expansion of the enamel, which must closely approximate to that of the metal on which it is to be applied, and (3) the elasticity of the enamel must be such that it does not easily chip.

Melting Temperature.

At the Blythe Colour Works every enamel is tested in an electrically-controlled muffle by an electric pyrometer, and the melting points of the enamels vary from slightly below 700 deg. C. to slightly over 900 deg. C., this difference being necessary according to the type of article to be enamelled. When dealing with the formulæ it will be shown how these melting points can be varied.

Expansion of Enamels.

Here one encounters the biggest difficulty in enamelling, and it may interest one to state that all good modern enamels are built up with the object of this being correct. In the case of steel for enamelling purposes the cubical coefficient of expansion is 0.00004, and it has been found that an enamel to fit this must have an expansion of approximately 0.00003—that is, the enamel covering must be in a state of slight compression, and it is only under these conditions that the enameller does not get "crazing" or "shivering."

The world owes a debt to the scientists of the Jena Glass Works—Winkelman and Schott, and also to Mayer and Havas—for the work they did on the coefficients of expansion of the different oxides which make up the composition of glass.

It will be sufficient to state that the variation of expansion coefficients is very large; if B_2O_3 is expressed as unity, then Na_2O is 100. The formula of a clear cover enamel and its composition is shown in Table I.

TABLE I.—*Formation and Composition of a Clear Cover Enamel.*

	Percentage.	Expansion coefficient.	
Na_2O	12.7	10.0	127.0
B_2O_3	16.9	0.1	1.7
K_2O	6.0	8.5	51.0
Al_2O_3	10.0	5.0	50.0
SiO_2	45.0	0.8	36.0
Cryolite ..	9.2	7.4	68.0
			333.7

The hardening factors, from a temperature standpoint, are the silica and alumina; it therefore follows that by decreasing these and increasing the others, or *vice versa*, the melting temperature can be varied; but here we are up against the problem of retaining the coefficient of expansion, and with the number of variants in the coefficients it becomes a mathematical problem.

Elasticity.

Winkelman and Schott have also published figures dealing with the modulus of expansion of glasses on the same lines as for expansion. The following figures give Young's Modulus for the different oxides. Young's Modulus is "the force required to stretch a substance of unit length and unit cross-section to two units of length, expressed as kilograms per sq. cm." They are as follow:—

SiO_2 .. 65	B_2O_3 .. 20	ZnO .. 15
PbO .. 47	MgO .. 600	Al_2O_3 .. 160
As_2O_3 40	BaO .. 100	Na_2O .. 100
K_2O .. 71	CaO .. 100	P_2O_5 .. 38

It follows, therefore, that the lower this modulus of elasticity, the more easily is the enamel stretched, and the author has recently made an enamel containing a very high percentage of zinc oxide, which has the lowest modulus and the results are very satisfactory. Unfortunately, some makers of enamels see a statement such as this and, without any further ado, proceed to add zinc oxide to their enamels, without considering the other factors, and in many cases the results are disastrous. Sufficient has been published to show that modern enamels are not mere guesswork and "rule-of-thumb" formulæ.

Sheet Steel Enamelling.

This concerns Falkirk, and includes hollow-ware sign plates and stove parts chiefly. In the first place, the article to be enamelled must be cleaned, and the usual method is to degrease either by solution or by "burning" at approximately 600 deg. C. The latter method is most practised, and is commonly known as "scaling," the articles being generally dipped in HC_1 before heating. The steel is then "pickled" in a solution of HC_1—one part of commercial acid to two of water. After pickling, the article is washed in clean water and finally dipped in a solution of sodium carbonate, approximately 1 per cent. solution. This is all that most hollow-ware manufacturers do, but there are advantages in putting the articles into a weak solution of borax before proceeding to the enamelling proper.

The ware is now ready for the enamelling process, which consists of a first coat or "grey" as termed locally, or a "grip" coat in America, and one or more cover coats of white or coloured enamel. The first coat generally contains oxide of cobalt, and it is strange that the addition of, say, 0.5 per cent. of this material alters, very considerably, the adhesion of the enamel. The following is a typical example of an American ground coat:—Borax, 25 per cent.; $NaNO_3$, 5.0; Na_2CO_3, 6.5; CaF_2, 7.5; felspar, 31; MnO_2, 5.0; SiO_2, 19.5; and Co_2O_3, 0.5 per cent.

This, after being melted, is ground in a ball mill with the addition of about 5 per cent. special clay, which, being colloidal, holds the powdered enamel in suspension, and 40 per cent. of water, until it will pass a sieve of about 50 meshes to the inch. The article is coated with this slush, either by spraying or dipping, allowed to dry and heated in the muffle at 850 deg. C.

Cover Coat.

In most cases this is white, and the following is a typical German formula:—Borax, 27 per cent.; cryolite, 15; felspar, 30; $NaNO_3$, 4.5; quartz, 16; and Na_2CO_3, 7.5 per cent. This is smelted as before and ground with the addition of 5 to 10 per cent. tin oxide and 5 per cent. clay, and the process of application is similar to that of the ground coat. In some cases, instead of oxide of tin, or in addition to it, oxide of antimony is smelted with the enamel.

Where this is done, it is necessary that the enamel should be of such composition that the whole of the antimony oxide should be converted to the insoluble, innocuous metanimoniate of soda or potash.

Coloured Enamels.

For the production of these, the colour-maker has ransacked the earth's minerals, and perhaps the oxide which is most used is that of cobalt, entering as it does into the composition of blues, blacks and certain greens. Perhaps it will be simplest to take the case of the white cover-coat enamel and say that, instead of adding white oxide of tin, prepared colour oxides are added. In some few cases, for blue or black enamels, oxides of cobalt, manganese, etc., are melted in, and even in these cases the prepared oxides or stains, as they are known, are often added, according to the result required. In all other cases the prepared oxide is added when milling the enamel.

It is beyond the scope of this Paper to deal with the manufacture of these colours; suffice it to say that chemicals of the purest quality are intimately mixed, in the case, say, of a blue-green—chrome oxide, cobalt oxide and alumina—then fired in saggars or crucibles at a temperature of about 1,400 deg. C. The fired material is then crushed, ground almost to impalpability, washed and then dried.

Cast-Iron Wet Process.

This process, which has been developed in America during the last few years, and applied

* A Paper read before a meeting of the Falkirk Section of the Institute of British Foundrymen, Mr. Thos. Shanks presiding.

mainly to the enamelling of gas-stove parts, follows closely on the lines of sheet-steel enamelling with the exception of the cleaning of the article to be enamelled. This is done by means of a sand blast at from 60 to 80 lbs. pressure. The term "sand" includes broken flint or "steel" shot. In the case of colours of mottles, the enamel can in most cases be applied direct to the casting, but in the case of white enamel it is usual to apply a ground coat on which to base the white enamel. Generally, enamels used for cast iron have a lower fusing temperature than those for sheet steel, but in their chemical structure are much the same. The ultimate success of cast-iron enamelling depends as much on the ironfounder as the enameller, the former's portion of the work being to produce a casting of clean iron and of even thickness throughout.

Cast-Iron Dusting Process.

This is the method used for large articles such as baths, and without a doubt it is the method which gives the best finish to an enamel. The enamel is much thicker in application than in the other process, and consequently a much better porcelain finish is obtained. In addition to this, no extraneous material, such as clay, is milled into the enamel, and additions at the mill always tend to reduce the finish of an enamel.

It is here, more than in any other enamel, that the coefficients of elasticity and expansion are of the greatest importance, and in a large number of factories lead enamels are still used in order to overcome this difficulty. All the enamels mentioned, and those made by the Blythe Colour Works, are leadless and absolutely free from deleterious materials. In cast-iron enamelling of either type, it is necessary that the base on which to enamel should be of the best, heavy lugs as well as dirty iron being detrimental to the best results.

Let us deal with the enamelling, say, of a 5-ft. 6-in. parallel bath with a 3-in. roll, an article which is in daily use. The bath coming from the foundry is first sandblasted, any small holes stopped up with a refractory "filling" and the ground coat is put on, generally by wet spraying. This bath weighs somewhere about 3cwts. and takes considerable handling; the bath is run on travelling forks into the muffle and heated to muffle temperature, say, 850 to 900 deg. C., and this heating fires the ground coat into the casting. The bath is withdrawn from the muffle and placed on a revolving and tilting cradle, and two operators powder the enamel over the red-hot casting, one doing the body of the bath and the other the roll and edges, the bath at the same time being revolved and tilted according to the will of the men who are dusting. Incidentally, the cradle may be worked either mechanically or electrically, and the sieves containing the powdered dry enamel are vibrated either electrically or pneumatically. The bath, having received its coating of enamel, is put back into the muffle for a short period to "flow" the enamel, withdrawn and allowed to cool.

Low-carbon Cupola Cast Irons.—According to a report of G. DELBART and E. LECOEUVRE in "Rev. Métallurg.," cast irons containing 1.7 to 2.5 per cent. C, 1.6 to 4.5 per cent. Si, 0.36 to 3.75 per cent. Mn, 0 to 0.77 per cent. Cr, 0.07 to 0.37 per cent. P and 0.026 to 0.097 per cent. S were prepared in a cupola and a maximum tensile strength of 35 to 40 kg. per sq. mm. found with a composition of 2 to 2.4 per cent. C, 2.9 to 3 per cent. Si, 0.5 per cent. Mn, 0.08 per cent. P and S, while the values for the other alloys varied between 30 and 35 kg. per sq. mm. The maximum hardness is found with 1.6 to 1.8 per cent. Si, although alloys with 2.5 to 3 per cent. Si and more than 2 per cent. Mn were uniformly hard in sections of various thicknesses. Low bending and shear strengths are found with high Mn contents, which restrain growth. High-manganese cast iron should be tempered at 300 deg. to obtain the optimum mechanical properties.

Determination of Silicon in Steels.

By FRED THOMPSON (Blackburn Technical College).

Although it is well known that in the determination of silica in silicates accurate results can be obtained only when several dehydrations are made, it has long been the practice of steelworks chemists to consider the amount of silica left in iron solutions after a single dehydration as being negligible. However, in the last few years there have been several attempts to show that for accurate work more than one dehydration was necessary, especially if the silicon content be high. Reports show that, when cast irons are analysed by the nitro-sulphuric acid methods the results are low, and that for decisive work several evaporations cannot be avoided.

Stadeler, a German chemist, while studying the relative advantages of the various methods for silicon, had three steels of different silicon contents analysed by twelve laboratories, employing five different methods. All of these laboratories found silicon in the filtrate after a single dehydration. The twelve laboratories varied widely in the percentages of silicon recovered in a second dehydration, averaging 0.01, 0.02 and 0.14 per cent. on an 0.8, a 0.3 and a 4 per cent. silicon steel respectively.

For the exact determination of silicon in steels, it is found that the best method to adopt is to dehydrate with sulphuric acid and then to recover the dissolved silicon by volatilising the iron as the ferric chloride by means of hydrochloric-acid gas. The following procedure has been employed successfully:—One or more dehydrations, according to the procedure given below, were made in one-litre platinum dishes provided with platinum covers. The filtrate from the last dehydration was evaporated to dryness in the covered platinum dish, the sulphuric acid expelled by gentle ignition and the residue finally heated to redness. The dish was cooled and the residue transferred to a small platinum boat. This was then placed in a silica tube in a split-type electric combustion furnace, heated to 400-700 deg. C., and a slow current of dry hydrochloric-acid gas passed through the tube. The hydrochloric-acid gas was generated by dropping sulphuric acid upon heated ammonium chloride and dried by bubbling through sulphuric acid. The residue adhering to the dish was treated with a few mls. of hydrochloric acid, transferred to a platinum crucible and the solution evaporated to dryness. When most of the iron in the boat had been volatilised, the residue was carefully brushed into the crucible containing the residue from the dish. The contents of the crucible were treated with a few drops of dilute sulphuric acid, which was driven off by heating the crucible on a radiator. The residue was next ignited in a muffle at 1,050 to 1,100 deg. C. to constant weight, treated with 10 ml. hydrofluoric acid and a few drops of dilute sulphuric acid (1 to 3), and the amount of silica determined by evaporation to dryness on a radiator, igniting and weighing. The weight of the non-volatile residues average about 0.15 gram. The first few times the volatilisation procedure was used the initial dehydration was made by the perchloric-acid method, because it was believed that residues from perchloric-acid solutions could be converted to oxides more readily than those from sulphuric-acid solutions. Later experiments with sulphuric acid showed that the residue from a sulphate solution was in a better condition to be attacked with hydrogen chloride than residue from perchloric-acid solutions. The following five methods are all applicable for large or small quantities of silicon.

Sulphuric Acid Method.

Dissolve about 5 grams of the steel in 100 ml. of sulphuric acid (1 to 4). Evaporate the solution, taking care to avoid spattering, until copious fumes of sulphuric acid are evolved. Continue the fuming for 2 to 4 min., but no longer, lest insoluble sulphates be formed. Cool somewhat and add 125 ml. of warm water (40 to 50 deg. C.). Stir until salts are in solution, heating lightly if necessary, but never to boiling. Immediately filter, cleaning the dish thoroughly. Wash the paper several times with dilute hydrochloric acid (5 to 95) to remove most of the iron salts, and then several times with hot water. Transfer the paper and contents to a platinum crucible, char the paper at a low temperature, preferably in an electric muffle, and finally ignite to constant weight at 1,050 to 1,150 deg. C. Cool in a dessicator and weigh. Moisten the silica with a few drops of dilute sulphuric acid (1 to 3), add excess of hydrofluoric acid (3 to 5 ml.), evaporate to dryness in an air bath, ignite and weigh.

Nitro-Sulphuric Acid Method.

Dissolve about 5 grams of steel in 80 ml. of nitro-sulphuric acid mixture (2,000 ml. of sulphuric acid sp. gr. 1.84, 1,500 ml. of nitric acid sp. gr. 1.42, and 5,500 ml. of water). Evaporate until copious fumes of sulphuric acid are evolved. Cool somewhat and cautiously add to the warm residue 5 ml. of hydrochloric acid (sp. gr. 1.19) and 125 ml. of warm water (40 to 50 deg.). Stir and warm until salts are in solution, but do not heat strongly unless salts cannot be otherwise dissolved. The heating should not require more than 5 min. Immediately filter and proceed as above.

Perchloric Acid Method.

Dissolve the steel in 60 ml. of dilute nitric acid (1 to 1). When the solution is complete add 60 ml. of perchloric acid 60 to 70 per cent.). Evaporate to fumes of perchloric acid, cover the dish, and continue heating at such a rate that the solution boils and the perchloric acid refluxes on the sides of the dish for 15 to 20 min. Cool somewhat, add 125 ml. of hot water, and proceed as above, with the exception that the larger residues from high-silicon steels must be washed well with hydrochloric acid (1 to 1) or they will decrepitate badly when ignited.

Hydrochloric Acid Method.

Dissolve the sample, 5 grams, in 60 ml. of hydrochloric acid (1 to 1) in a 400-ml. beaker, evaporate to dryness, and bake for one hour at 105 to 120 deg. C. Baking at temperatures higher than 120 deg. C. will produce residues which dissolve with difficulty. Drench the hot residue with 15 ml. of hydrochloric acid (sp. gr. 1.19), stir for about one minute, add 125 ml. of hot water, continue stirring until salts are in solution, and proceed as sulphuric-acid method.

Hydrochloric Acid-Ammonia Method.

Proceed exactly as in hydrochloric-acid method but add 5 grams of ammonium chloride before evaporating the solution to dryness. The addition of ammonium chloride causes the baked residue to be more readily soluble.

Fatigue and Impact Strength of Steel.—In "Jernkontorets Annaler," O. FORSMAN gives a report of investigations carried out at the Government Testing Institute, Stockholm, on the effect of low temperatures on the properties of a carbon steel for shafts and railway axles, a CrNi-steel for shafts and of an ordinary rail steel. All the steels tested were of Swedish manufacture. Tensile tests were carried out at room temperature, fatigue tests on test-bars for one-sided load at room temperature and at − 18 deg. C., and notched-bar impact tests at different temperatures between − 60 deg. C. and + 40 deg. C. The fatigue limit was found to rise slightly with falling temperature. As previously known, the tensile strength has the same tendency. The impact tests confirmed that there exists a critical region between about − 20 deg. and + 20 deg. C. within which the impact figure falls swiftly with falling temperature. The transition from the high-level to the low-level may be gradual as was the case with the steels for axles and shafts or discontinuous as was found for mild steel for building purposes. The transition range may be affected by heat-treatment.

How Sand Control Pays Dividends.

COMMERCIALISING NEW DATA.

Mr. F. Hudson's excellent Paper "Methods of Commercial Moulding-Sand Control for the Modern Ironfounder," which has appeared in our last two issues, when presented in Manchester, disclosed in the discussion the real interest now being taken in this subject of vital importance to every foundry owner.

The discussion was opened by the PRESIDENT (Mr. Arthur Phillips), who said that when the Paper was published it would probably be regarded more as a work of reference than merely a Paper. Probably many would desire to receive further information concerning "Bentonite," and to know what was its composition and what it would do. Possibly some of them were fully acquainted with what it was and for what purpose it was intended, but others might not be so fully instructed. Another point of interest was what was the relative cost of Wood Extract? Apparently, these were the two chief items used in regard to the new sand in the foundry. In the Lancashire District the problem was always present to foundrymen in regard to the use of old sand.

Then, there was the question of the resistance of the rammed sand. The lecturer had stated with regard to one of his figures that 100 jolts gave the best results for test purposes. On a practical demonstration for ramming a valve body in a box, and turning the top part over, and taking the number of blows to knock it out with a piece of iron, the figures in the table shown indicated that 150 jolts gave the best results. It would be interesting to learn what number of jolts the lecturer recommended for this casting in order to ensure the best results being achieved in the foundry.

The Question of Scabbed Castings.

If one had a series of scab castings and also found the castings were too rough, what method would the lecturer use to produce castings which would not sell unless they had a smooth finish? In regard to the Osborne jolt machine, for green sand the hardness figures were stated to be 4.1 to 4.5. Would the same moisture conditions prevail for jolt and hand-rammed? When an amount of sand was trepanned out, that which was hand-rammed weighed 155 grammes, whilst that from the Osborne jolt rammer weighed only 137 grammes. The table showed a harder surface when using the Osborne jolt machine, and yet there was a less weight with the trepanned section taken out. These two conditions could hardly be reconciled, probably he might have reversed the figures through taking them hurriedly down, due to the short time the slide was on the screen.

Bentonite and Colbond.

MR. HUDSON stated that "Bentonite" was a colloidal clay imported principally from U.S.A. and Canada, and was, really, 100 per cent. clay. It was very much like flour, and was supposed to have been formed through extreme volcanic disturbances. It existed in a natural state and merely required grinding. It was somewhat expensive, and cost, approximately, £14 to £20 a ton. Latterly, a substitute for "Bentonite" had been introduced in this country, which was known as "Colbond." It was very similar to "Bentonite" in being 100 per cent. clay, and it was cheaper in price. He would like to read a letter from Messrs. Colbond commenting on the comparative efficiency of "Bentonite" against "Colbond," as mentioned in his Paper.

MR. A. PEARSALL, in a written communication, stated, in reference to the relative strengths of "Colbond" and "Bentonite," he agreed that if a high moisture content was maintained, the author was justified in assuming only a half value for "Colbond."

However, at between 1 and 2 per cent. of "Colbond" and up to 5 to 6 per cent. moisture, the value of the bond was between 3/5ths to 2/3rds that of "Bentonite," but he would stress the advantage of "Colbond" in the following respect:—"Colbond's" refractoriness is definitely superior to that of "Bentonite" and it is much less easily burnt out. This advantage is particularly notable on steel and heavy cast-iron work.

MR. HUDSON, in reply, referred to the survey of rebonding clays mentioned in his Paper, and said it should be pointed out that the test mixture used was composed of:—77 parts dried sea sand; 20 parts dried green-sand floor sand, and 3 parts rebonding clay under test. This mixture was milled for 5 min. at both 4 and 6 per cent. of moisture, and the test results obtained at these moisture contents showed "Colbond" to be 50 per cent. efficient in comparison to "Bentonite." Furthermore, the moisture content that could be safely used in the working of sand or clay gave one an indication of the likely green and dried-bond strengths available, and it would be found that the more water required the greater the amount of clay grades present. Alternatively, if a sand required less moisture, it definitely indicated a weaker sand. The question of refractoriness and longevity is not vitally important to the grey-iron founder, and these points, in the past, had received greater stress than was necessary.

Wood Extract.

Continuing, Mr. Hudson said the price of "Wood Extract" varied according to quantity ordered, but a fair average price was round about £8 to £9 per ton. It was a by-product of the paper industry, and was imported mainly from Canada and Newfoundland, Norway and Sweden.

Dealing with the percentage of defective castings, the laboratory at the Glenfield Works had rather the honour of being blamed for most of the defective castings produced in the shop, and, in fact, the laboratory was responsible to the management for defective castings, because they were directly responsible for the metal and for the moulding sand. The foundry foremen have had to control method, labour, and produce the output. As far as possible all raw materials were under scientific control. Nevertheless, there were still a few jobs which ran out, or were defective, when the moulder forgot to put in the smallest core of the batch. The point has been reached when the further reduction of defective castings entails intensive supervision over that most variable element of all — the human element. The finish of the castings in the foundry at the present day was greatly superior to what it was twelve months previously.

Influence of Jolting on Sands.

The point with regard to jolting was rather a hard one to answer, because jolting depended principally upon the type of sand used. The point he had endeavoured to emphasise was that the flowability in a moulding sand determined how many jolts must be given to the sand. If the sand was too strong it did not matter how long the jolt was, as the sand was never properly rammed, although the velocity of the jolt impact might be sufficient to compact it. In the case of a very weak sand, the longer the jolt the harder the mould surface became, and so compacted that probably the metal would not lie on it. To begin with, the sand had to be what was classed as a "satisfactory" sand. It must have just the correct bond and adequate permeability. With such a sand, the jolting period for normal castings from, say, 2 cwts. up to 10 cwts., at any rate, would be round about 88 to 120 jolts, 100 being a very good figure, and usually about 15 per cent. more than what the makers of the machines predicted they could do.

Skin and Permeability.

A point had been raised with regard to the relation of surface finish and the prevention of scabs. When a smooth-surfaced casting was desired many problems could be discussed. To begin with, permeability by itself was of no real value, because if there was no gas generated by the mould, permeability did not matter. His own view of producing a smooth-skinned casting free from scabs would hinge particularly on obtaining a correct dried strength. Many green-sand moulds in use at the present day appeared to have a satisfactory green bond—he made the statement advisedly—and yet when the sand was dried the bond disappeared entirely. In his opinion, the dried-strength of a green-sand mould was infinitely more important than the green strength, the latter being only necessary in order to obtain the plasticity for moulding purposes. If the strength deteriorated during pouring, and every green-sand mould was for a few seconds during casting a dry-sand mould, then there would be scabbing. It might be that the sand was deficient in dry strength; on the other hand, it might be that the coal-dust percentage was so excessive that far greater gas was being generated than the natural permeability of the sand would stand.

An attempt had been made, by means of the tables, to give some indication as to the amount of gas present in the mould as well as the permeability. It was not possible to answer the Branch-President's question in a direct way, because there were so many variables to take into account. The only way probably in which a reasonable answer could be given to the question was by examining the foundry practice and probably testing the sand. If Mr. Phillips cared to avail himself of the opportunity, and send him (the lecturer) a sample of the sand, he would be pleased to test it for him. The test could then be compared with the result shown in the table, and it would be possible, perhaps, to indicate what was wrong.

With respect to the Osborne jolt machine and the hardness test, the green-sand values of 4.1 and 4.5 were not the hardness values, but the green-bond values.

Life of Modern Sand Plants.

MR. A. SUTCLIFFE (Bolton) inquired how long the sand-treating plant would last, and whether blacking was used on the mould. It would be interesting, also, to learn if the lecturer had had any experience with the use of sawdust. Three or four moulders might be engaged on the same class of job, and every one of the castings would be different, although they were all using the same kind of sand. Twenty years ago he had more loam than sand moulders. The plant described would not mix loam or clay. It was necessary for the sand to be uniform in quality. A point upon which he would like to receive information was whether Mr. Hudson had experienced any trouble with the use of water containing acid. He, the speaker, used core sand, which cost 2½d. a cwt., and this was milled in a pug mill carrying treaded and plain rollers. It seemed to him that the plant described by Mr. Hudson would not be suitable for the majority of jobbing shops, although it could be adapted for a textile machine foundry or a light-castings shop. Had Mr. Hudson experienced any trouble with regard to the coal dust carrying a high ash content?

MR. HUDSON said that the plant described in the Paper had now been installed two years, and that his firm had the reputation for making a good engineering job. He appreciated the fact that some foundry plant was not made to last any considerable length of time; therefore they designed the plant for themselves, and then got the equipment people to co-operate and make it for them. There was not a bearing on the

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plant that was not a roller bearing. In every instance, where sand might be able to get into the bearings, the bearings were protected in order to prevent it doing so. If Mr. Sutcliffe could spare the time to visit the foundry, he would be gladly welcomed, and he would then be able to see for himself that it was a well-designed job.

Mould Surfaces and Casting Finish.

Blacking was not used on the mould surfaces except for certain castings which had to have an ornamental finish. Most of the castings were protected from corrosion in some way, such as by the use of Dr. Angus Smith's solution or by dipping them in tar, and it was debatable as to whether a smooth finish was an advantage in this direction.

The bulk of the castings in the dressing shop were, however, comparable with the finish of castings made by 95 per cent. of the jobbing foundries in the country; the only people who could probably excel them being those who made a point of getting an extraordinarily high finish, such as Harpers, of Willenhall, and some of the light-castings people.

At one time sawdust was incorporated in dry-sand mixtures, but they could never ascertain what real advantage there was in doing so. Like other additions, such as horse-dung, etc., they did not appear to affect the permeability of the sand very much.

Coal Dust and High-Ash Content.

Coal dust and ash had not proved to be any source of trouble, because the firm had a definite specification for coal dust, and the suppliers had to conform to that specification. New deliveries were analysed in the laboratory, and if the ash content was too high then the suppliers had to take their coal dust back.

Why did Mr. Sutcliffe still adhere to loam moulding? Surely, making a skin-dried mould was cheaper than using loam. His firm were endeavouring to cut out loam work as much as possible. They formerly used loam in the manufacture of hydraulic cylinders and rams, for which there seemed to be now a scarcity of orders. The plant was certainly not designed to mix loam. What was now desirable was to fix a standardised green sand, which with suitable modifications could be used for making castings formerly made of loam.

The modified green sand referred to in the Paper was perfectly satisfactory. Castings had been made with it which were formerly made entirely with the old dry-sand mixture, with excellent results.

Troubles from Polluted Water.

Undoubtedly water quality played an important part, particularly in the case of oil-sand cores, but apparently it did not play a very great part in regard to the ordinary sand continuing clay bond. When used for mixing oil sand it was important not to use polluted canal water or anything similar to it. In Scotland there was a plentiful supply of clean fresh water, and all the moulding sand used by the firm was tempered with fairly pure water. Therefore, he had not as yet had to overcome any particular problem with regard to the use of polluted water for moulding operations.

He noted that Mr. Sutcliffe's core sand cost 2½d. a cwt., which was 4s. 2d. a ton. His own firm were to-day using core sand which cost 1s. 9d. a ton, so there was a direct saving in that respect. Tests were being undertaken at the present time with regard to the production of a semi-oil sand-core mixture for heavy castings, and it was hoped that the cost would work out at not more than 1s. per ton.

Elimination of Facing Sand and Transport.

MR. H. SHERBURN (Warrington) considered that the Paper provided a great fund of information for those fundrymen who had been brought up in what might be termed the school of experience. The problem of sands, and moulding sands particularly, was so complex that it was necessary for the problem to be dealt with by technically-trained people as well as the practical men. It was obvious that all through the Paper the practical side of the question had not been overlooked, and doubtless the practical foundrymen with whom Mr. Hudson was associated had rendered considerable assistance.

One thing he would like to have heard something about was in regard to the cutting action of the flowing metal, particularly in the vicinity of the runners. This was a matter of great importance. Another point was, of course, that the process described by the lecturer dealt with the whole of the sand operated in the foundry. He was not dealing with a facing sand, as such, which was obviously the common practice, and the one most commonly followed at present in the absence of general mechanisation. This, in itself, created limitations, while it possibly had certain advantages.

It would be of interest to know if Mr. Hudson had considered the question of the fusibility of the different sands, which was, again, a matter of primary importance. Certain new sands had been tested recently, and it was surprising to note the difference in the fusibility of the common sands commonly in use in the Lancashire district.

Another point of moment, as far as he (the speaker) could understand, was that the use of new sand in Messers. Glenfield & Kennedy's foundry must be almost a negligible quantity. This suggested, of course, that the problem of clearing out old sand, and that of bringing new sand into the works, had been largely eliminated, and hence one of the problems of the foundry as to the movement of materials had been largely solved.

Cutting Action of Metal on Sand.

MR. HUDSON replied that a little trouble had been experienced at one time with regard to the cutting action of the flowing metal. The trouble took the form of the bottom of the Runner gate washing into the casting. This was found to be entirely due to the excessive use of the swab. Most of the firm's castings were made in half-boxes, and the runner gate was usually mounted on the pattern plate. In drawing this gate pattern the workmen were apt to use a heavy swab containing a great deal of moisture, and the extra moisture naturally weakened the sand. In many cases trouble was experienced at the gates from this cause. By omitting to use the swabs on the gate pattern the cutting ceased, owing to the increased strength of the sand at that point.

The sand referred to in the Paper was regarded as being quite equal to facing sand. There were two foundries in the works—one a light foundry, handling the bulk of the production, and the other a heavy foundry, making jobs of anything from 2 tons to 60 tons in weight. The heavy foundry handled special work, and until very recently did not use the same type of sand as was used in the light foundry, namely, a cheaper sand. The cost of the facing sand used in the heavy foundry worked out at 9s. a ton. It was decided to use the light foundry mass-production sand as a facing sand in its stead. This was done within the last month or so in regard to some very heavy sluice gates, and the castings came out better than when using facing sand.

The Old and the New.

The method of preparing this facing sand was that the sand was mixed on the foundry floor by the moulders and then put through an aerating machine. It was not milled. It was considered now that the green sand was actually superior to the facing sand, and the bond was greater and the permeability was better. The foreman in charge of the heavy shop was very adverse to trying it; he could not see how it could possibly be better. He now admitted it was far better than the old facing mixture.

In regard to refractoriness, or fusibility, sands varied considerably. When carbon was added to sand its refractoriness was increased. Carbon could be added in the form of coal dust, as wood extract, core oil, or as heavy mineral oil. The refractoriness was then increased enormously. Erith loam was a sand with a low index of refractoriness, and at temperatures below that of cast iron it vitrifies and tends to slag. By adding 5 per cent. of carbon in the form of coal dust to the Erith sand it will neither glaze nor melt. This was a very important point in the effect of carbon in increasing the refractoriness of a sand, and was one of the main benefits of coal dust.

The refractoriness of new sands varied, but his line of thought at present was not to use new sand! in fact, his ambition was to produce high-quality castings from scrap alone, using no sand and having no defective castings.

In further reply to the remarks of the President, he then answered, with the aid of figures on the blackboard, Mr. Phillips' question with regard to the surface hardness and the jolt test.

Book Review.

German-English Technical Dictionary for Ferrous Metallurgy. Part 1. German-English, by HENRY FREEMAN. Published by Otto Spamer Verlag G.m.b.H., Heinrichstrasse, Leipzig, C.I. 25 R.M.

One of the greatest difficulties encountered by English readers of foreign technical journals is the absence of real technical words and phrases in many so-called technical dictionaries. Familiarity with the subject is often the only way of determining the true meaning of a given foreign word, and, as readers and translators are not always experts in all subjects with which they have to deal, there often appears a translation which is somewhat bewildering even to the technical reader. The dictionary under review certainly ranks as one of the most useful technical dictionaries among the dozen or so which the reviewer has had occasion to use. The publishers claim that two-thirds of the words are "pure technical words," and while no attempt has been made to verify this claim, a careful examination discloses reasonable justification. What is more, the "pure technical words" include both the German *and the English or American* terms, which means that the compiler has carefully combed the English and American technical journals for the counterparts of German technical words. Dealing with iron and steel metallurgy, the dictionary is remarkably complete and accurate. It is a pleasure to find at last such translations as *Vorherd = receiver* and *Mischkristalle = solid solution* (a stumbling block for most dictionaries), and *Biegeversuch = transverse test* (in cast iron). The dictionary covers recent technical developments, phrases in sand testing, case hardening, coremaking, etc., being well covered, although "core-blower" has been missed. It is interesting to note that the term "sand slinger" has been co-opted into the German technical language, a compliment to American descriptive etymology. Incidentally, American spelling has been used where no confusion is likely to ensue, although in doubtful cases cross reference to the English equivalent is given.

One very useful feature is the incorporation of numerous conversion tables, conversion factors and technical abbreviations, which are so often troublesome when studying German technical reports. The conversion factor for *kg./mm.²* into *tons/sq. in.* (*0.635*) has been omitted. The compiler has produced a really useful dictionary in a compact form and which can be recommended to all who read the German technical Papers dealing with iron and steel.

F. K. N.

Foundry Mechanisation.*

By A. S. Beech.

Much definite progress in the mechanisation of the foundry industry has taken place in these last few years and mechanical plants have been, and are being, installed in various parts of this country. It cannot yet be said, however, to have approached the installations which can be found in almost every Continental country, but it has made considerable headway. It is interesting to recall that several years ago the author uttered a warning that he was convinced that the foundries which had the courage or conviction to instal these plants would reap the benefit. From innumerable personal visits to foundries, it is noteworthy to record that without exception the foundries which have mechanised their shops have been kept constantly employed, despite the past terrible depression, and are to-day in almost every case employing actually more men than before mechanisation, but, of course, are also obtaining greater production per man employed. It is a very remarkable thing also, that industries of every description which have brought mechanism to their aid have been very well occupied right through the slump, and are now in a splendid position to take advantage of any trade revival.

The Automobile Industry.

Take, as an example, the motor industry. This is an industry that naturally lends itself to mechanisation, not only in the production of castings, but also in the machine shop, assembly shop and other branches. The motor firms which have mechanised have been working full time right through the depression, whilst those companies which lagged behind have not been so fortunate. Surely this is a lesson which progressively-minded foundrymen should keep in front of them. Here there is an industry producing what is, after all, a luxury, and it can keep its shops going right through a trade depression, the like of which has never been experienced in the world before.

British foundries which bring their shops up to date, and keep them so, have nothing to fear for the future, but, on the other hand, those which lag behind and wait until something turns up, are going to be left by the roadside in the competition for world trade. Thus tariffs, trade barriers, or whatever other artificial artifice may be erected in this country or abroad, will make no difference if British foundry owners take advantage of every possible means of keeping their plants up to date in order to be able to fight the competition which is certain to be experienced, coming from industrial nations situated in every quarter of the globe.

Types of Foundry Mechanisation.

These can be placed into three groups, as follows:—(*a*) Semi-mechanised or intermittent plants, (*b*) fully-continuous plants and (*c*) high-production, specialised continuous plants.

Semi-Mechanised or Intermittent Plants.

It has often been said that it was not possible to bring mechanical aid to the jobbing foundryman because of the large variety of work which he had to handle, and that the only thing to do was to continue in the old-fashioned way. It must be admitted that this branch of the industry presents the most difficult problem to solve, and it is very difficult to see how it ever will be completey solved. Nevertheless, there are methods which can be utilised to get rid of some of the laborious and unnecessary labour and thus assist the loose-pattern moulder to exercise his wonderful skill instead of making him into a semi-glorified labourer or errand boy.

Unquestionably, in some cases, unsuitable and dirty moulding sand is provided for the hand-moulders, and yet, by nothing short of a miracle, they have turned out the castings which they have done. These castings, however, very often cost more money than they should do, because the moulder has to do a considerable amount more handwork than would have been necessary if he had been supplied with properly-prepared moulding sand. Then, again, the fettling costs are frequently in such cases higher than they need be, because of this poor sand.

There are still many jobbing foundries of which the only sand-conditioning equipment consists of a riddle and an old-fashioned mortar mill. The author has frequently pointed out in technical Papers and discussions the damage that these mortar mills do to the sand, and it is not proposed to repeat these remarks. Instead, attention is directed to Fig. 1 showing an up-to-date sand reconditioning plant, and one which can in the long run certainly prove to be an economical proposition.

The plant illustrated is installed in a foundry in the South of England, and has a capacity of two to three tons of facing sand per hr. The plant consists of three hoppers, which are below floor level, namely, one large hopper to contain old sand and two smaller ones to contain new sand and coal dust respectively. At the bottom of these hoppers are fitted rotating discs, fitted with ploughs, which can be regulated in such a way that the amount allowed to go forward can be controlled by adjustment.

The mixture of the old and new sand and coal dust is discharged into the boot of the No. 1 elevator on the right-hand side of Fig. 1, which passes it into the screen at the top. The screen consists of a sheet-metal casing within which rotates a cylindrical riddle. From this screen it falls into the hopper situated over the sand mill. From there it falls by gravity through a hand-controlled valve into the sand mill. This mill is of a special design, which will be described later. Discharge from the mill is in this particular case effected centrally by means of a rack-and-pinion-operated guide plate.

On leaving the mill the sand passes to a second elevator which feeds the disintegrator, which is of the double revolving disc or peg type, each disc revolving inside the other in opposite directions, and the sand passing between them. From the disintegrator the sand passes into the finished-sand hopper and can be drawn away at will, as the hopper is closed or opened by means of a counterweighted flap.

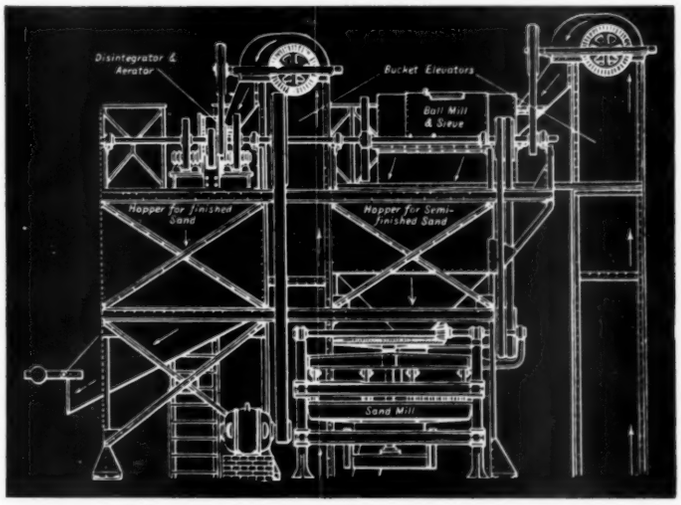

FIG. 1.—A MODERN SAND-PREPARING PLANT.

Continuous Sand Mill.

Fig. 2 shows the latest type of continuously-operating sand mill. It must be stressed here, however, that these mills can be constructed to work either intermittently or continuously according to the special requirements of the shop in which they are installed. The machine is generally fed from an overhead supply tank which has an automatic variable discharge. The machine gives an intense rubbing action on the sand, and as the mullers are adjustable for height and are spring-loaded they rise and fall with the thickness of sand underneath them and definitely no crushing action takes place on the silica grains, as is certainly the case with the old types of mortar mill and also in the type of mill where the pan of the mill does not revolve.

The machine is fitted all over with ball bearings totally enclosed and dust-proof. Drive can either be by means of a belt or by direct motor drive and reduction gear. Inside the pan are a large number of scrapers, made of ordinary angle-iron, also a series of baffle plates, made of steel bars mounted in sockets and adjustable for angularity are provided. These baffles are controlled by means of screws and hand-wheels and can be set to any required angle, which latter determines the length of time the sand remains in the mill; hence the output and time of working are variable at will. Centrifugal force tends to throw the sand towards the periphery of the pan, but the adjustable baffle plates overcome this centrifugal action and force the sand towards the centre of the pan. The effect of this and the numerous flat and angular scrapers is that the sand is very intensively agitated, mixed, rubbed and aerated. The capacity of the mill shown in Fig. 2 is 30 tons of excellent sand per hr., but a range of machines dealing with 2 tons up to 30 tons of sand per hr. is available..

The author is indebted to a user for permission to publish his comments, as after all it is the most convincing argument on a question of this description.

The letter of this actual user of a similar sand mill to that shown in Fig. 2 contains the following interesting information. The letter is dated October 18, 1933, and reads as follows:—

"Prior to the installation of the sand reconditioning mill in August of this year (note only two months ago) the sand used in our continuous casting plant lacked the proper bond

* Paper read before the Wales and Monmouthshire Branch of the Institute of British Foundrymen at Newport, Mon.

and was extremely hot when reaching the moulders' hoppers, and was responsible for many bad lifts and consequently the low output of good moulds. After the installation of this continuous mill and the special disintegrator, and after the stock of sand in the system had been reconditioned, we found that not only had the bond considerably improved, but the temperature of the sand was reduced by as much as 20 deg. Fah. (11 deg. C.), and the number of bad lifts decreased very considerably.

"Over a period of 32 working days the total number of good moulds put on the conveyor was 37,404. The bad lifts, of which a daily

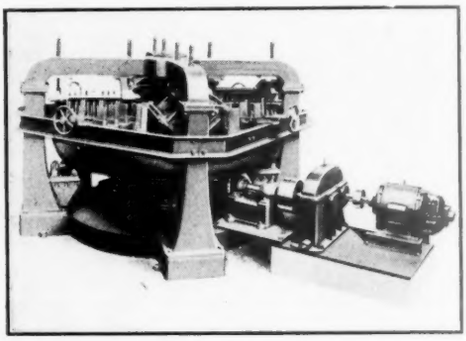

FIG. 2.—SHOWING DETAILS OF THE SAND MILL INCLUDED IN THE PLANT ILLUSTRATED IN FIG. 1.

record was kept for the 32 days in question, was 470, the percentage being 1.256—a very considerable improvement over the previous conditions.

"Regarding new sand added to the system, for a production of 5,696 boxes in a particular working week our records show that the total weight of sand used in the system was 621 tons 4 cwts. 2 qrs.

"The new sand added to the above was 5 tons 2 cwts., the percentage of new sand thus being 0.821, or less than 1 per cent. At the present moment we are not adding the new sand and coal dust automatically, and therefore we issue to each machine a supply of facing sand for sieving on.

"The total amount of facing sand issued in the week mentioned above was 3 tons, 17 cwts. equals 0.62. Coal dust being 0.113, the *total* percentage to the 621 tons 4 cwts. 2 qrs. including with facing and backing sand was 1.544.

"A further advantage has been that the machine operators gained confidence as a result of being supplied with this good-quality sand.

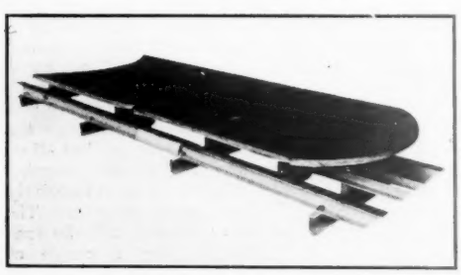

FIG. 3.—SHOWING DETAILED CONSTRUCTION OF A MOULD CONVEYOR.

"Considerably less tucking of boxes is required, resulting in an improved output of 33⅓ per cent over that obtained before this very excellent sand mill and disintegrator were installed."

Jobbing Foundry Mould Feeding.

The transport of sand to individual moulders is a big proposition, but it can be solved. Where the boxes are not of very large dimensions and where they do not vary considerably in overall sizes, a system of overhead feed can be arranged in a very practical way. This system is very interesting. The moulder works in a certain defined space very much in the same way as the plate moulders in Falkirk and other districts in Great Britain. The hoppers move along on rails and are fed at one point by belt and plough from overhead.

When the hand-moulder requires a supply of sand he pulls his hopper along the rails until it is over his moulding box and then opens the discharge mouth and allows the sand to fall into the moulding box. The moulder then pushes his travelling hopper out of the way and makes his mould. After casting the box he knocks out the mould over the grid and the sand falls through on to a travelling belt which takes the sand back to the sand plant, where it is re-conditioned and brought back to the hoppers once more. When the moulder requires a further supply of sand in his hopper he pushes it back to a predetermined place where it is fed once more from the belt and plough.

For the ordinary jobbing foundry using boxes of varying dimensions, depths, etc., the problem is more difficult, but a good solution is the automatic distribution of sand to one or more positions of the hand-moulding floor within easy distance of the hand-moulders. The automatic disposal of the sand after casting could be arranged by fitting up a long grid over which the boxes could be knocked out and the sand conveyed back to the sand plant.

Another problem which has to be solved when considering the question of intermittent plants is the non-ferrous foundry and the steel foundry. In both these cases the supply of molten metal is not continuous, and consequently the remedies adopted in the continuous iron foundry where molten metal is always available, cannot be applied to the non-ferrous or steel shop. Nevertheless, considerable economies can be effected by the introduction of an efficient up-to-date sand plant, and further, a knock-out grid running right along the shop, even in front of the hand-moulders.

The sand can be conveyed by means of a travelling belt under this long grid and pass automatically to the sand plant, where it would be treated automatically and conveyed to the individual hoppers, situated over each moulding machine, and the surplus conveyed into a large storage hopper for use by the hand-moulders. The moulding machines can be arranged in a definite position and in front of each machine two sets of gravity-roller conveyors can be placed, one horizontally to receive the moulds from the machine and on which the moulds are cast. The other gravity roller can be on the slant to take the empty boxes back from the knock-out grid to the moulding machines. This demonstrates a simple, but very effective, way of dealing with the mechanisation of the non-ferrous and steel shop.

Fully-Continuous Plants.

Naturally, these plants are only applicable to the cast-iron foundry where a continuous supply of molten metal is available and where there is a demand for repetition castings. Repetition castings are much more in this country than is generally assumed by the ordinary layman. When one considers the vast requirements of the railways, the electrical constructors, the builders for housing schemes, the demands of local authorities for manhole covers and grids and street grids, the tremendous demand for castings for domestic articles, such as mincing machines, lawn-mowers, scales and a variety of other articles, it will be understood that this type of mechanisation is the most popular of the three types which are listed for description.

It is very common in this country, and indeed all over the continent of Europe, to find foundries requiring to produce castings in large quantities but varying in length, width and depth. This is quite a good applicable case for such a plant.

In an article* by Mr. V. C. Faulkner, the illustrations he used showed a plant of recent construction which can certainly be claimed as coming within this category. The castings produced on this plant are all light castings of varying sizes and nature, it being understood that large quantities of each type of casting are required. The plant is very simple to understand; the moulding machines are all situated inside the mould conveyor. The moulds are made on the machines and are placed on the mould conveyor, which takes them round to the pouring station, where they are poured, and travel on to the two jolting knock-out grids.

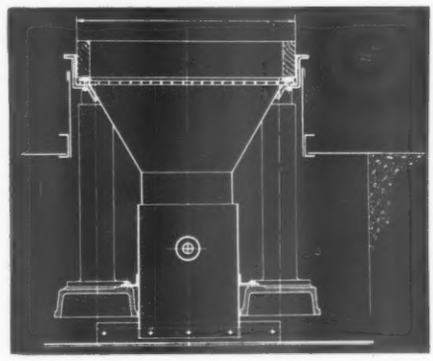

FIG. 4.—A NEW TYPE OF AUTOMATIC KNOCK-OUT GRID.

The sand falls through these grids and travels on a cross belt and is joined by a supply of new sand and coal dust the quantity of which is definitely controlled. It then travels and feeds itself on to the long inclined belt conveyor at the top of which is situated a magnetic pulley which rids the sand of any iron pellets or tramp metal. From there it is fed into the storage tank.

At the bottom of this storage tank another feeder belt extracts the sand and feeds it into the boot of the first elevator, which lifts it and feeds it to a rotary screen from whence it is taken by a further belt and fed into one of the continuously-operating sand mills, previously referred to. From the mill it again passes into the second elevator, which lifts it and passes it on to a belt feeding a disintegrator, from which

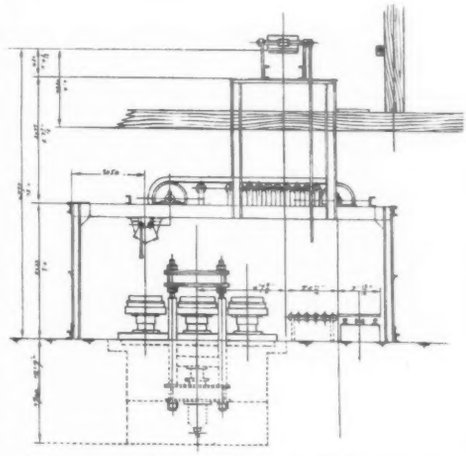

FIG. 5.—A NEW TYPE OF MOULD HOPPER DELIVERING PREDETERMINED QUANTITIES OF SAND.

it passes on to a horizontal belt, feeding the individual hoppers situated over each moulding machine.

The sand is fed into each hopper as required and any surplus is fed into the overflow shute

* "The New Mechanised Foundry of the Sinclair Iron Company, Limited," FOUNDRY TRADE JOURNAL, page 305, November 30, 1933.

at the end of the plant and is again reintroduced into the system. An additional conveyor belt is running under the moulding machines for the purpose of receiving all the spilt sand from the moulding machines.

Mould Conveyor.

Fig. 3 shows a section of the mould conveyor in use on the above plant; it was explained in the article referred to in the footnote to page 8 that the conveyor had a complete table top, and that the gaps between each plate usually associated with mould conveyors were not in evidence. This is quite an important point for various reasons, the first being that in certain cases it is necessary and advisable for the man pouring the casting to be able to travel at the same pace as the mould itself. Hence in this case he can mount on the table top without any danger to himself and pour the mould as the conveyor travels. This would be distinctly dangerous, if the conveyor had gaps between the plates. Another point is that this complete surface gives a much larger actual operating surface on which to place and pour the moulds, whilst a further advantage is that, as all the working parts of the conveyor are covered by these plates, it is impossible for the pourer to let a stream of metal fall on any working part.

It will be seen from Fig. 3 that the top cast-iron plates run on rollers, situated at each end of the axle. This axle is made of forged steel, and carries two supplementary rollers, which are only guide rollers, for assisting the conveyor round the corners. The entire conveyor is of massive construction, but owing to the almost complete absence of friction, is driven round, with an extremely small amount of motive power. Recently the author saw one of these conveyors loaded with 80 tons distributed load, driven very easily with a 3-h.p. motor, and as it was started up under this load, it must be assumed that the actual running consumption was much less.

A further interesting point about this conveyor is the drive. There are no long chains which invariably stretch unevenly over their entire length, and cut into their driving sprockets, but the drive is accomplished by means of a double short-length chain of about 8-ft. pitch, operating on both legs of the conveyor. The conveyor works remarkably sweetly, and has been in actual operation in a number of foundries now for several years, and has given no trouble whatsoever. It is fitted with a variable-speed arrangement, so that the speed can be altered at will.

Automatic Jolt Knock-out Grids.

A further interesting inclusion in this plant is the jolting grids shown in Fig. 4. There is no doubt that in the past by far the most disagreeable work on a continuous casting plant is at the knock-out. Anything, therefore, which can be done to relieve the men at this point is very desirable. One of the great troubles at this particular place in the past has been that the box has had to be man-handled in order to disturb the sand, more or less compactly rammed, out of the box, and this, as can quite easily be understood, has meant considerable disagreeable work for the men, with hot castings, sand and boxes.

The introduction of this automatic jolting grid has, however, considerably eased the situation for those men at this point. The men simply place the box on to the jolting surface and the sand is automatically jolted through the screen, leaving the box and castings resting on the top of the grid. All the men have to do afterwards is to put the boxes on to a special conveyor, taking the empty boxes back to the moulding machines. This is certainly a great improvement over the old-fashioned stationary grid.

Mould Hoppers.

Before leaving this plant, attention is called to a new type of patented hopper, for feeding sand into moulding boxes, in predetermined and definite quantities, by push-button control, which is shown in Fig. 5. Sand, as is well known to everybody connected with the foundry industry, is inclined to bind together when it arrives in congested areas, especially when the clay content is high. The old type of hopper over moulding machines was generally rectangular or round, terminating in a jaw operated by a handle.

This, in order to store a sufficient quantity of sand over the machine, necessitated making a hopper with a large orifice at the top, and with sloping sides ending in a smaller orifice just above the operating jaws. The result of this was a tendency to pack the sand in the smaller orifice, and sticking up of the sand in the hopper. It was quite common practice to see men hitting hoppers with wood mallets, or having a vibrator attached for the purpose of loosening the sand when it stuck.

The ultimate result, therefore, was that very frequently the operator obtained either a great rush of excess sand or insufficient. Therefore this new type of patented hopper has been introduced to overcome these difficulties. At the bottom of the hopper a belt is placed supported by conveniently-placed rollers, and this belt is controlled by a small motor, operated by a push-button control. The travel of the belt is arranged to give a definite predetermined amount of sand each time the operator presses the control button into the supplementary feed hopper, shown on the screen. When the operator opens the jaws of the shallow supplementary hopper, he obtains definitely just the amount of sand he requires to make his mould, no more and no less. A further advantage is that whilst he is operating his machine he can press the button and fill his supplementary hopper ready for the next mould. This, again, saves seconds, which amounts to quite a considerable total at the end of the day.

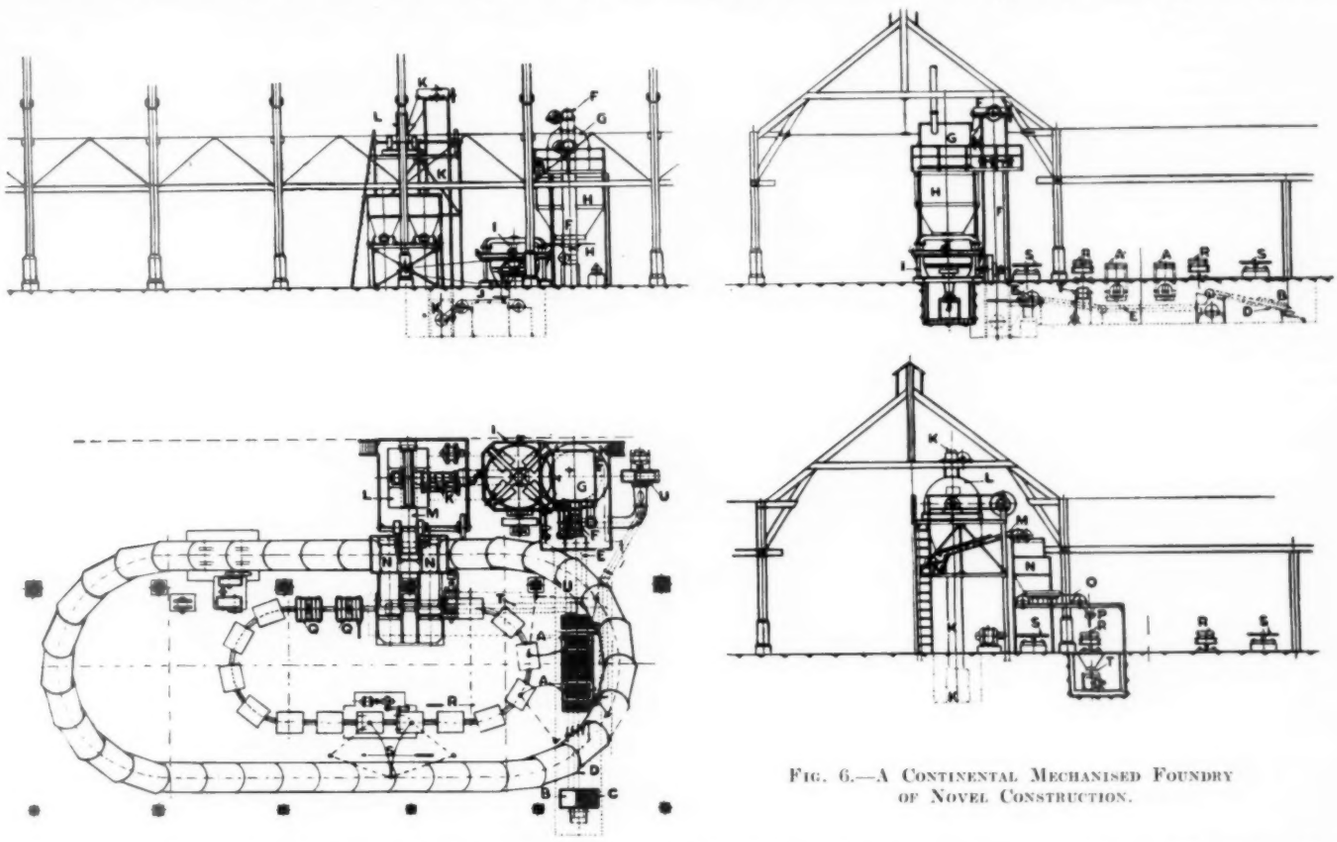

FIG. 6.—A CONTINENTAL MECHANISED FOUNDRY OF NOVEL CONSTRUCTION.

High Production, Specialised Continuous Plants.

The subject has now reached what might be termed the final class of mechanised plant. Previous considerations have embodied what are termed jobbing shops and ordinary repetition foundries, but there are also the foundries to be catered for which, year after year, have intensive

production of one or two types and sizes of casting only. Unfortunately, these shops are rare, but they are becoming more common, as an inevitable result of the demand for the mass produced article.

The first remarkable point about the plant shown in Fig. 6 is the comparatively small floor space occupied by the entire plant, namely, 82 ft. long by 49 ft. wide to outside of the plant. It will also be seen that there are two conveyors, one inside the other. The internal conveyor "R" carries 18 pattern-plates, around each of which is fitted an under-sand frame, the main principle of which is to push the pattern-plate into the sand, and not the sand into the pattern. The advantages of this system are quite apparent. These 18 pattern-plates are split pattern-plates, and therefore make nine complete moulds.

Each pattern-plate contains part of a stove, and hence the 18 pattern-plates make an entire stove.

The requirements of this company are for stove parts for two or three sizes and types of stoves only, and, consequently, it is possible to run this plant without changing the pattern-plates for many months at a time, but in any case the size of the moulding box never changes. The boxes are approximately 41¼ in. by 30 in. inside, and the entire production of castings for the various types of stoves have all been so arranged that this size of box will take all the castings which go to make up their two or three types of stoves. Naturally, in most cases, there are several different castings in the one box, and if any scrap is made, the mould is re-made, with the previously good castings "stopped off."

This internal conveyor is operated electrically, by means of a push-button, worked by the man at the moulding station. The external conveyor "D" is used for conveying the boxes to the pouring station, and for allowing the necessary cooling time, and, finally, to convey the boxes to the automatic knock-out grids "A." From these automatic grids, the sand passes over a belt and magnetic pulley "E," and *en route* picks up a definite amount of new sand and coal dust from the hoppers provided, "B" and "C." The belt "E" feeds the sand into the boot of the first elevator "F," from which it is fed into the revolving hexagonal screen "G."

The hexagonal screen not only takes out any foreign matter, such as pieces of wood and stones, from the new sand, but also tends to assist in the cooling of the sand by flinging it round and round. From the screen the sand then falls into the large silo "H," at the bottom of which is situated a revolving plate with a scraper and metallic adjustable curtain arranged in such a way that a continuous and definite supply of sand can be obtained.

The sand is thus fed automatically, and in the desired quantities, to the continuously operating sand mill "I," the details of which were given earlier. The sand having been milled, mixed, and further cooled by this mill, is then automatically and continuously taken away by transporter belt "J" which feeds the sand into the boot of the second elevator "K," whence it is discharged into disintegrator "L," which thoroughly aerates the sand, breaks up any lumps or balls, and delivers it to the endless belt "M," that feeds it into the bin "N." This bin is part of the special type of feeding hopper, to feed the moulding machines with a definite and predetermined amount of sand, which was also described earlier in this Paper. The above describes the complete movement of sand throughout the plant.

Ramming Moulds.

As was mentioned above, the boxes are all of one definite size, namely, approximately 41¼ in. by 30 in. inside. The internal conveyor is revolved two steps at a time, and as the two boxes pass under the two filling stations "P," so they are filled with the desired amount of sand from the special hoppers "P," which were explained previously. The moulds are then strickled off, and when this is done the internal conveyor is revolved two more steps forward, which passes the two boxes just filled up, under the two pressure heads "Q," and whilst these moulds are being rammed simultaneously, the operators at filling stations "P" are filling the next two boxes ready to come forward. It should be noted that there are only two moulding machines on the entire plant to give the output to be detailed later.

Changing of Pattern Plates.

The pattern plates are located by means of two register points only, and are just resting by their own weight on the conveyor pallets, consequently there are no pins to unfasten, and the whole pattern plate and under-sand frame can be changed in about two to three minutes.

Speed of Production.

The *average actual* production of these boxes, the dimensions of which are not small, is 112/115 complete moulds per hour, from the two moulding stations only, and the total number

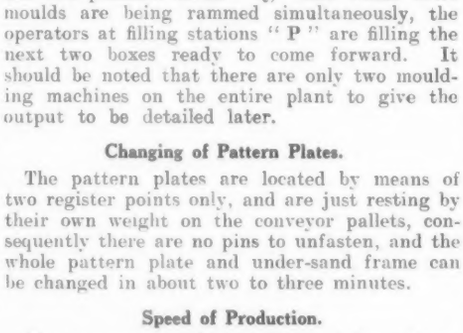

FIG. 7.—A VIEW OF THE FOUNDRY SHOWN IN FIG. 6.

of men engaged is 16 men and 3 boys, who do everything, including pouring and knocking out, clamping and unclamping, moulding, etc. A further interesting point about this plant is that, prior to the installation, the company found difficulty in employing their men during the entire week. The plant has now been working about twelve months, and it is now running 16 hours per day on two shifts, and the management is considering duplicating the plant in the near future. This is a striking testimony to what was mentioned at the start of this Paper, and goes to prove that firms who have brought their plants up to date have benefited and are benefiting by their foresight, despite the trade depression.

If the author were asked what were the most striking improvements in mechanised plants which have taken place in the last few years, he would stress the following important items:—(1) The specialised type of plant just described for the intense manufacture of one type of casting only; (2) the new types of continuous sand mills; (3) the steps taken to see that sand is efficiently and properly cooled after knocking out till it arrives once more over the moulding machines; (4) the almost total elimination of metallic belts driven by chains for extracting sand from hoppers, and their replacement by belts of special fabrication for this purpose; (5) the adoption of the new type of mould conveyor with complete table top, with its manifest advantages; and (6) the invention of the new type of hopper to give a definite predetermined amount of sand into the moulding box.

It will also be patent to everybody that these plants have to be studied individually to suit each and every foundry where they are to be applied, and that no universal lay-out can be adopted to suit every case. It follows, therefore, that they are dangerous things to experiment with, and the only really satisfactory way of installing such plants is to take advantage of the experiences and difficulties which have been overcome in the past by successful companies specialising in these problems.

The *average* outputs from a plant installed in this country for making rainwater castings are: 110 moulds per hr. from one pair of moulding machines, the size of the box being 21 in. by 11½ in. This output is an average output over a period, and not a production, say, over one hour, but is a definite average output of *good* moulds, taken over a definite given period. Anybody could probably get extraordinary results for five minutes, or perhaps for one whole day, but this is of no importance whatsoever. What is important, is to ascertain the average number of good moulds made definitely every hour or every day, on a strictly commercial basis.

The Late Mr. J. A. S. Hassal.

As briefly announced in a recent issue, Mr. J. A. S. Hassal died just before Christmas. Few people were better known or more generally esteemed in the foundry industry than Mr. Hassal, who for many years was the secretary of the National Ironfounding Employers' Federation. He was a chartered accountant by profession, having served his articles with Messrs. Harmood, Banner & Son. In 1892 he established himself in business in partnership with the late Mr. Knox, as "Knox & Hassal." In 1919, he was joined by his eldest son, Mr. John S. Hassal, since when the firm has been known as Knox, Hassal, Son & Company, at 106, India Buildings, Water Street, Liverpool.

Mr. Hassal was born in 1868 and was educated at King William's College, Isle of Man. As a young man he was a prominent Rugby football player, until in 1903 he became a pioneer of motoring and in 1906 founded the Cheshire Automobile Club. He took a prominent part in municipal matters, and sat as a conservative member of the Birkenhead Council from 1922 to 1928. He was secretary of quite a number of engineering and foundry employers' associations, and a director of a number of local companies.

On behalf of the foundry industry we extend to his family our deepest sympathy.

Marking of Imports.—The National Union of Manufacturers has addressed to all manufacturers' trade associations and to its members a questionnaire inviting their views as to the desirability of reversing the operation of the Merchandise Marks Act. The Board of Trade, with whom the Union has been in communication regarding the matter, is desirous of knowing how much demand for this change in the law there is amongst United Kingdom manufacturers. The view of the Union is that all foreign goods on importation into this country should be marked unless a sufficiently strong case for exemption, to the satisfaction of a statutory committee, can be made out by the importer. The present measure, enabling any industry which can make out a case to the satisfaction of a statutory committee, to obtain an order to the effect that a particular class of goods imported into this country must bear an indication of origin on importation or sale, or both, was no doubt the best that could be obtained for industry in the circumstances which obtained in 1926. Now that protection is the established system of the country, and all goods imported into this country have to be examined to determine what duty, if any, is payable, the Union feels that there is no longer any good reason why the onus of procuring Orders in Council, with all the expense and trouble and delay which the process involves, should remain on the shoulders of the home manufacturer. Manufacturers are asked in the questionnaire for their views, should the change in the law be made, as to marking the goods merely as foreign or indicating the country of origin.

A Metallurgist's Outlook on Modern Foundry Production.*

By J. R. Handforth, M.Sc. (London).

The basis of these observations is frank admiration of the products of the foundryman. In the first place, he has moved with the times, for the castings he made for the winner of the Gordon Bennet Race in 1902 would have been somewhat out of place for Sir Henry Segrave's car, the "Golden Arrow." His products are now subjected by engineers to conditions which a few years ago would have been regarded as ridiculous, and it may perhaps be interesting to print a user's opinion of the foundryman's productions, which read (Mr. Scott Paine's cable):—

"Just finished hardest race ever run. I stressed your engine harder than any machinery I have ever handled. It is a marvellous example of British engineering."

In the engine which Mr. Scott Paine used for his motor boat there were many castings, for example, the crankcase, cylinder head, oil sump, rear end cover, pump bodies, carburettors, valve guides, etc.

It will obviously be impossible to cover, even in summarised form, the whole of the casting industry, so it is proposed to deal only with those branches in which the author has been in personal contact, and he would like to deal with them in the order in which he was introduced to them.

The Steel Foundry.

This branch of foundry work is important, full of difficulties, and, what is perhaps more to the point, now turning out products which are replacing those of the non-ferrous foundries in dye works, food machinery, chemical plant, ornamental castings and in fields of general engineering.

The chief point of note about the steel foundry is its profusion of melting equipment—the crucible, the open-hearth furnace, the Bessemer converter, the side-blown converter Robert or Stock, the various types of electrical-arc furnaces and latest of all the high-frequency induction furnaces. The object of all these plants is to meet the foundryman's first difficulty, the need for molten metal at very high temperatures, say 1,450 to 1,600 deg. C. These high temperatures are responsible for many further difficulties. It is obviously no easy matter to obtain moulding refractories which will resist such temperatures, and it is not to be expected that steel castings can be produced with the same clean surfaces as are obtained on aluminium castings poured at 700 deg. C.

Further difficulties of the steel founder are the high liquid and solid contraction of his metal, which involve large runners and risers, and the quick breakdown of his moulds to avoid shrinkage cracks. Having produced his sound casting, he is then involved in the art of heat-treatment in order to relieve casting strains, to soften his metal for machining or to achieve the physical properties of his specifications.

Much time, money and thought has been, and is still being expended on these difficulties. The reports of the committee on the Heterogeneity of Steel Ingots are wonderful evidence of the determination of the steel foundrymen to master their difficulties.

Just as in the manufacture of wrought steels so in the production of cast steels, the foundryman uses many different types of steel to meet the engineer's requirements. One steel foundry, recently visited, casts metal to twenty-eight different specifications. Of the straight carbon-steel castings such as are used for engine components, turbine cases, lorry parts, etc., the majority have a carbon content of 0.25 per cent., and these when annealed have a tensile strength of 28 to 32 tons per sq. in. For higher test castings—say 35 to 40 tons per sq. in.—the carbon is raised to about 0.4 per cent.; but except for special work such as cast die blocks with carbon 0.6 to 0.75 per cent. this figure is not frequently exceeded in plain carbon steels.

With regard to alloy-steel castings, modern foundries produce steel of almost every conceivable composition, for example, with 1 to 1.5 per cent. manganese for gears, caterpillar shoes, wagon wheels, nickel steels for bridge work; nickel-chrome steels with 3 to 3½ per cent. nickel and 0.45 to 1.75 per cent. chromium for high-duty gears, mill rolls, excavator buckets; carbon-chrome steels (0.5 to 1.0 per cent. carbon, 0.5 to 1.0 per cent. chromium) for crushing and pulverising machinery; high-manganese steels (carbon 1 per cent., manganese 12 to 14 per cent.) for stone breakers or tramway crossings; stainless-steel castings with 14 per cent. chromium, and corrosion-resisting steels of the usual austenitic types for chemical and textile work or oil-cracking plant. Of recent years considerable trade has been developed in castings of high alloy content for resistance to scaling in enamelling furnaces, automatic stoker parts and high-temperature chemical-reaction vessels.

Another interesting process which is now in the course of development is the centrifugal casting of high-alloy steels, whereby both costs of material and machinery can be reduced.

The Iron Foundry.

During the past five years very wonderful progress has occurred in this branch of the foundry industry, such progress that even non-ferrous metallurgists and foundrymen must note and respect. Under the circumstances one cannot even pause to consider the remarkable results which have arisen from the mechanisation of iron foundries, but must confine the subject to the metallurgical examination of their modern products. Briefly, these may be classified as:—(1) The production of cast irons with mechanical properties so improved that they compare favourably with those of steel castings; (2) the production of castings capable of heat-treatment, with Brinell hardness ranging from 350 to 700, and (3) the production of austenitic irons with properties which open up entirely new fields for the use of cast iron and bring it into direct competition with non-ferrous castings.

Alloyed Cast Irons.

Broadly speaking, these modifications have arisen through the introduction into cast irons of the alloying elements nickel, chromium, molybdenum, vanadium, titanium and aluminium, and it is stated by Coyle that 198,000 tons of such alloy cast irons were produced in America in 1929. When correctly used, these elements refine the grain of cast iron and reduce the size of the flakes of graphite; they reduce shrinkage and porosity, and thereby improve the strength of the castings; they can be used to prevent the formation of chill where it is undesired and so improve machining qualities, or to increase the chill to give castings exceedingly resistant to wear and abrasion.

With regard to the first of these modifications, *i.e.*, castings with better mechanical properties, it is now comparatively easy to produce grey-iron castings with 18/22 tons tensile. The essential conditions are that the T.C. should be not greater than 3.2 per cent., and that the particles of graphite should be as small as possible. This was formerly achieved by melting low-carbon pig-iron with steel scrap, but it is now usually accomplished by the use of nickel and chromium which widen the basic irons which can be used, and which give at the same time castings with finer grain and greater density. A typical example of such an iron might have the composition T.C. 2.9 per cent., silicon 1.25 to 1.5 per cent., nickel 1.8 to 2 per cent. and chromium 0.25 to 5 per cent. Large quantities of iron similar in type to this (T.C. 2.75 to 3.15 per cent., silicon 0.9 to 1.1 per cent., manganese 0.6 to 1 per cent., nickel 1 to 1.5 per cent., chromium 0 to 0.6 per cent.) are now used for motor-car components such as cylinders and cylinder heads.

Cast irons with still higher mechanical properties, *i.e.*, 20-30 tons tensile, are now produced by (1) melting steel scrap with suitable proportions of high-silicon pig-iron, (2) the addition of alloying elements to the ladle, and (3) the heat-treatment of alloyed white irons.

The heat-treatment of cast irons, apart from simple annealing, is a natural corollary to the introduction of alloying elements. Nickel lowers the critical speed at which castings need to be cooled to produce martensite, and thus enables them to be safely but effectively quenched in oil instead of water. Chromium increases the hardness of castings by the formation of carbides, and the two elements together refine the carbide net work. Small quantities molybdenum (0.25 to 0.35 per cent.) are said to increase the toughness of cast iron. The usual method of heat-treatment is to harden in oil from 850 to 900 deg. C. and then temper at 200 to 400 deg. C. This method is in fairly general use for the production of motor-car cylinder liners with a Brinell hardness of 450 to 500. High-duty gears have also been produced in the same manner.

If the alloy additions are sufficiently increased, for example, up to 4½ per cent. of nickel and 1½ per cent. of chromium, not only is the combined carbon content increased, but the matrix of the casting is changed from pearlite to sorbite or martensite, and by this means intensely-hard white cast irons with a Brinell hardness of 600 to 700 may be obtained. These have found considerable use in grinding and crushing machinery.

One of the most interesting examples of heat-treated alloy cast iron is that now being produced by the nitriding of centrifugally-cast low T.C. iron containing 1½ per cent. of aluminium and 1½ per cent. of chromium for cylinder liners. In the as-cast condition these have a tensile strength of 20 to 25 tons with a Brinell hardness of 350 to 400. After nitrogen hardening, the tensile strength is approximately 30 tons per sq. in. and the Brinell hardness 900 to 1,000.

Austenitic Cast Irons.

The most remarkable change in the ironfoundry industry has been the introduction of austenitic cast irons. These are obtained either by the use of high percentages of nickel, 20 to 30 per cent., or more generally by the combined use of nickel, copper, manganese and chromium. Typical compositions are:—

	T.C.	Si.	Ni.	Cr.	Cu.
1	2.75–3.1	1.25–2.0	20–30	1–4	Nil.
2	2.75–3.1	1.25–2.0	12–15	1.5–6.0	5–7

Copper, if used alone, is only soluble up to 2 per cent., but this solubility is appreciably increased by the addition of nickel. Manganese is twice as effective as nickel in producing austenite, but the resulting castings are difficult to machine. Chromium improves the strength of austenitic irons and greatly increases their resistance to heat and corrosion. By suitable combinations of these elements, castings are obtained with remarkable and valuable physical properties. Nomag with 10 per cent. nickel and 5 per cent. copper is non-magnetic and useful for switchgear and electrical machinery. Nimol and Niresist with 14 to 15 per cent. nickel, 6 to 7 per

* A Paper read before a joint meeting of the London Branches of the Institute of Metals and the Institute of British Foundrymen, Dr. Smithells presiding.

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cent. copper, 2 to 4 per cent. chromium are particularly resistant to corrosion, and compare favourably with bronze in resistance to acids and sea water. Most of these alloys have great electrical resistance and high coefficiencies of thermal expansion.

A further field for the use of cast iron has been opened by the development of irons especially resistant to heat and scaling, and which compare favourably with expensive steels of high-alloy content. Two of these, Silal (T.C. 2.5 per cent. plus 5 per cent. Si) and Nicrosilal (T.C. 2 per cent., silicon 5 per cent., manganese 1 per cent., nickel 18 per cent., chromium 2 to 5 per cent.), have been developed by the B.C.I.R.A., and others containing T.C. 2.5 to 3.0 per cent., silicon 1 to 2.5 per cent. and chromium 16 to 30 per cent. have been developed in America.

Alloys of Copper.

The most noteworthy point of interest in this field of foundry metallurgy is the tremendous amount of research work which has been undertaken during the past ten years. Much of this work has been carried out by the B.N.F.R.A., and this association is to be heartily congratulated on the planning, organisation and practical success of its inquiries into the everyday problems of the foundry. As was right and proper, the early researches started with the element copper itself, and very valuable work has been carried out on the effect of small quantities of impurities, degasification and practical methods of producing sound copper ingots. In the same manner the production of sound ingots of 70/30 brass has been studied and the improvement of such brasses by the addition of 1 to 2 per cent. of aluminium has led to the commercial production of what are known as "self-healing" condenser tubes.

Manganese Bronze.

A noteworthy technical advance has been made by the introduction of the Durville process for the casting of copper-alloy ingots. The 60/40 brasses also have been thoroughly investigated and there are now improved manganese bronzes with various additions such as 1 to 1.5 per cent. of iron, aluminium, nickel and manganese, the successful handling of which has enabled us to retain in this country a large proportion of the world's trade in the casting of large ships' propellers. Of the further alloys of copper there is the standard gun metal 88/10/2, and its various modifications with 5 to 10 per cent. of each of tin, lead and zinc.

The bronzes, alloys of copper with tin and phosphorus, have been studied in minute detail both with regard to additions of other elements, such as zinc, nickel and lead, and with regard to the effects of sand casting, chill casting, and centrifugally casting.

The alloys in this class which have attracted attention recently are the cuprous bearings known as lead bronzes, and the alloys of copper with beryllium. Lead bronzes, which consist essentially of copper with 25 to 35 per cent. of lead, by virtue of their oil-carrying capacity and the fact that they are strongly alloyed with the steel supporting shells, have been found to function with entire success under conditions which have proved too arduous for the best tin-base anti-friction metals.

Beryllium.

Considerable research and development work is now in hand with regard to the metal beryllium. This element is in the aluminium-magnesium group, and is 35 per cent. lighter than aluminium, for its specific gravity is 1.85. It is claimed to produce very wonderful effects when combined with copper, for the resulting alloys are capable of precipitation hardening. The wrought alloys of copper and beryllium have found certain uses, as, for example, springs and carbon-brush holders, etc., but attention is now being paid to the cast alloys. For this purpose a "master alloy" of copper with 12.5 per cent. of beryllium is produced for use as a hardener. Owing to the extreme readiness with which beryllium alloys with oxygen, it is recommended that the melt shall be covered, even during casting, with a layer of wood charcoal, and that it should first be deoxidised by the usual additions before adding the beryllium. The alloys recommended are those containing 1.5 to 2.5 per cent. of beryllium, for which the casting temperature is 1,050 to 1,100 deg. C., and foundry practice is said to be similar to that for phosphor bronze. Heat-treatment consists of heating the castings to 800 to 820 deg. C. for not less than two hours, followed by immediate quenching in cold water and subsequent reheating for three to five hours at 275 to 300 deg. C. Temperature control during heat-treatment is of fundamental importance, because the copper-beryllium alloys begin to disintegrate about 850 deg. C. In the as-cast condition the Brinell hardness is approximately 100. After water quenching it is 60 to 80, and after tempering it rises to 420 to 440. With 2 per cent. Be, the alloy as-cast has a tensile strength of 30 to 32 tons per sq. in., with an elongation of 10 per cent. After hardening the tensile strength is raised to 55 to 57 tons, but the elongation falls to approximately 1 per cent.

It is claimed* that use for such castings has been found for bearing sleeves for variable-pitch aeroplane propellers, racing-boat propellers, cams, pinions and worm gears, and that castings of copper and beryllium are particularly useful wherever corrosion is a serious factor. These results are largely experimental, but when the price of beryllium is really commercial, it may have a definite use as a deoxidiser for copper alloys, particularly where electrical conductivity is of importance.

A Problem in Differential Expansion.

The steel cylinder of an aero engine has attached to it in some form a cylinder head which is usually an aluminium forging or casting. Into this head it is necessary to insert some type of valve-seat, because aluminium castings are too soft to withstand the hammering of the valves. Under running conditions the valve of the engine may be raised to a temperature of 700 to 900 deg. C.; the crown of the cylinder head may be 250 to 300 deg. C. and the exhaust valve seats will be some temperature between 300 and 550 deg. C. Under such conditions a set of difficult problems arises. In the first place, on account of the difference in the coefficient of expansion between aluminium and steel, difficulties are experienced in making an oil-tight joint between the header and the cylinder. If the two parts be screwed together, carefully-controlled interference fits can be used, but it is usually necessary to include also some form of collapsible packing gland. The same problem, slightly less serious, occurs if the head and the cylinder are bolted together. The high coefficient of expansion of the aluminium header introduces difficulties in regard to the retention of the valve seats. Attempts have been made to ease this trouble by screwing in the seats, heating up the heads and allowing them to shrink on to the seats or even by freezing the valve seats in liquid air and placing them in heated cylinder heads to allow the headers to shrink on to the seats and the seats to expand into the headers. Many types of seating materials have been tried, including Monel metal, hard aluminium-bronzes containing nickel and iron, and most recently a specially-manufactured steel, with a coefficient of expansion equal to that of aluminium. Even when these problems are solved, there remains the fact that under running conditions the aluminium alloy, be it forging or casting, becomes relatively soft and plastic, and there is a definite tendency of the metal in the neighbourhood of the valve seat to be distorted by the valve hammering, which results in irregular running conditions. That these are serious and practical difficulties is shown by the fact that in one well-known engine the aluminium header has been replaced by a casting of aluminium bronze, for it is counted that the advantage gained in oil tightness and freedom from valve-seat trouble more than counterbalances the increase in weight entailed by this change. This is a somewhat unusual example of a cuprous-alloy casting ousting aluminium alloys from a field where weight is of fundamental importance.

* Cone, American Foundrymen's Association, June, 1933.

Aluminium Castings.

In view of the remarkable changes which are induced in steel by the addition of nickel, chromium, tungsten, etc., it was for a long time hoped that similar improvements would be conferred on aluminium by the selection of suitable alloying elements. These hopes have in a large measure been unfulfilled, but appreciable advantages have been gained by the addition of zinc, copper, silicon, manganese, magnesium, iron, titanium and nickel. Modern progress is developing on quite different lines, such as:—(1) The better control of melting conditions; (2) the study of the effects of different elements on the casting properties of alloys; (3) modification of previously known alloys, particularly those of high-silicon content; (4) the development of increased resistance to corrosion, and (5) the application to castings of the principles of heat-treatment which were elucidated by the metallurgical study of duralumin.

A problem which for many years puzzled aluminium founders was the phenomenon known as "specky" metal. This problem was solved by Mr. S. L. Archbutt at the National Physical Laboratory, who demonstrated that speckiness was due to the release during solidification of the gases, particularly hydrogen and carbon dioxide, which are taken into solution in the aluminium during melting. It was shown that these gases could be removed by allowing the metal to solidify slowly or by blowing through it immediately before casting the insoluble gas nitrogen. Whilst these methods are used with appreciable success for special work which will bear the cost, they have not come into general use. They have had a very definite value, however, for large users of ingot aluminium now take precautions not only to control their melting equipment, as, for example, by the use of glazed crucibles and suitable fluxes, but they ascertain that their raw material is as gas-free as possible when it is purchased by them. Many other methods of degasification have been tried, such as the use of chlorine, carbon tetrachloride, silicon tetrachloride, aluminium chloride, titanium tetrachloride, or by the addition of small percentages of metallic sodium, and it is understood that considerable success in this direction has been recently achieved by a new method.

Much research work has been undertaken to determine the effect on casting conditions produced by various elements used in the production of aluminium alloys. Zinc is cheap, easily added, and, together with small percentages of copper, produces in L.5. for example, an alloy suitable for many purposes. This alloy is weak when hot and therefore liable to crack in the moulds, and it is not suitable for use at high temperatures. Copper alone from 6 to 12 per cent. produces harder alloys, which are less liable to hot shortness. They have been largely used for the production of die castings, but they are prone to be brittle.

Aluminium-Silicon Alloys.

Silicon has been one of the most useful elements in the metallurgy and founding of aluminium. It is present in small quantities in most ingot metal and it is added in quantities varying from 2 to 14 per cent. to produce a large and useful range of alloys. The alloy with 5 per cent. of silicon has found great favour in America on account of its good casting qualities. This alloy is tougher than the copper alloys, has less

shrinkage and has given good results in the production of thin castings subject to pressure tests. Such castings are remarkably ductile and very resistant to corrosion. Their physical properties can be improved by the addition of copper and two well-known alloys, Lautal with 4 per cent. copper and 2 per cent. silicon, and an English alloy with 8 per cent. copper and 2 per cent. silicon, are based on these principles. One notable advantage of the presence of silicon in these alloys is that it considerably reduces the ill-effects of high-iron content and therefore enables good castings to be made from secondary material. By increasing the amount of silicon to 11 to 14 per cent., the very useful alloys known as Silumin, Alpax or Wilmil have been developed. Such alloys produce excellent die castings, but if cast in sand in the ordinary manner they are prone to give unreliable results, because the silicon crystallises out in a coarse condition, which results in brittleness. This difficulty has been successfully overcome by the well-known process invented by Pacz, whereby the alloy is "modified" by the use of sodium or fluxes of alkaline earth fluorides, the general effect of which is to make the silicon crystallise in a fine state of division, so fine that it has been described as of colloidal dimensions. In this condition the alloy has excellent casting properties because of its fluidity and its short range of freezing, so that it can be run into exceedingly thin sections and be rapidly cooled. It does not suffer from hot shortness, and in the cold condition castings are sufficiently ductile to allow straightening. Silicon alloys of this description have a very low specific gravity and a very high resistance to corrosion. As sand cast they have an ultimate stress of 10 to 12 tons per sq. in., with an elongation of 6 to 8 per cent. Castings of this alloy have found considerable use in industry, but for highly-stressed components they are unsuitable, because, in spite of their good tensile strength, they have a very poor proof stress—viz., 3 to 4 tons, and low fatigue-strength. In order to overcome this weakness, alloys of this type have been slightly changed by the addition of 0.8 per cent. of copper, which does not alter the tensile strength but raises the proof stress by approximately one ton. Further improvements have been made during the past twelve months by the addition of 0.3 to 0.5 per cent. magnesium and 0.3 to 0.5 per cent. manganese. The manganese slightly increases the hardness and neutralises the ill-effects of iron and copper impurities, which weaken the alloy and reduce its resistance to corrosion. The magnesium makes it possible to improve the properties by heat-treatment. The treatments applied are either tempering at 150 deg. C. for 20 hours, or water quenching at 510 deg. C., followed by tempering at 150 deg. C. The changes in properties caused by these modifications are shown below (Table 1):—

TABLE I.—*Mechanical Properties of Al Si Base Alloys.*

Alloy.		0.1 per cent. proof stress.	Ult. stress.	Elong. per cent.	Fatigue strength.	Br.
13 per cent. Si	—	3–4	10–12	6–8	2.75	55–60
13 per cent. Si; 0.8 per cent. Cu	—	4–5	10–12	6–8	3	60–65
12 per cent. Si; 0.4 per cent. Mn; 0.4 per cent. Mg	As-cast ..	4.5	10–12	2–4	3.6	55–65
12 per cent. Si; 0.4 per cent. Mn; 0.4 per cent. Mg	Tempered ..	6–8	11–13	2–3	3.6	65–75
12 per cent. Si; 0.4 per cent. Mn; 0.4 per cent. Mg	Fully heat-treated.	13–16	16–18	5–1.5	4.86	80–100

It has been stated that the alteration in composition has rendered them very prone to speckiness.

Another high-silicon alloy for which appreciable use has been found is that known as Low-Ex, which has the composition:—Si 14 per cent., Ni 2 per cent., Cu 1 per cent., Mg 1 per cent. and Al remainder. This alloy, which has a Brinell hardness of 120 has at room temperatures a tensile strength of 14 to 16 tons. The tensile strength at 200 deg. C. is approximately 10 tons and at 300 deg. C. 5 tons per sq. in. Its coefficient of expansion is 0.000019, compared with 0.000025 for the normal alloys, and it has been used to considerable extent for the manufacture of automobile pistons.

Of the other alloying elements which have been added to aluminium, mention must be made of nickel and chromium. Generally speaking, the results from these two elements have been disappointing, but a Patent has recently been taken out covering alloys with the composition:—Cu 6 to 12 per cent., Ni 1 to 3 per cent., Cr 0.5 to 5.0 per cent. and Mg 0.5 to 2.5 per cent.

These alloys do not appear to be very promising for sand casting, but they are reasonably satisfactory for die casting. In the latter condition they have a Brinell hardness of 140 to 160, and they appear to retain their hardness at high temperatures better than any other of the cast aluminium alloys. After tempering for 100 hrs. at 250 deg. C. the hardness of a cast test-piece dropped only from 162 to 110.

Two alloys highly resistant to corrosion have recently been developed by the combination with aluminium of magnesium and manganese. One of these containing 6.5 to 7.25 per cent. of magnesium with 0.3 to 0.6 per cent. of manganese, known as Mg 7, is essentially a wrought alloy, but the second, with 4 per cent. of magnesium and 0.5 per cent. of manganese, known as Birmabright, is used in the as-cast condition for the manufacture of plant subject to atmospheric or sea-water corrosion, and for chemical plant subject to acetic acid, lactic acid, fruit juices, etc. In the as-cast state its physical properties are:—0.1 per cent. proof stress, 5.0 to 6.5 tons per sq. in.; ultimate stress, 9 to 10 tons per sq. in.; elongation, 3 to 5.5 per cent.; and Brinell hardness, 50 to 60.

Considerable progress has been made in recent years by the application to aluminium castings of the methods of heat-treatment which were first used for the wrought alloy Duralumin. Briefly, these depend on the behaviour of magnesium silicide (Mg_2Si) and copper aluminide ($CuAl_2$), which are only slightly soluble in aluminium at room temperatures, but which rapidly pass back into solution when the alloys containing them are heated to about 500 deg. C. If an alloy in the latter condition is cooled quickly by being quenched in water, these compounds, Mg_2Si and $CuAl_2$, are retained in the form of unstable supersaturated solutions, and these solutions when allowed to stand at room temperatures, or when gently heated to, say, 120 to 200 deg. C., gradually break down and precipitate the excess of the dissolved compounds. This process of internal decomposition within the crystals of the alloy has the effect of greatly increasing the Brinell hardness and the mechanical strength of the alloys, and whilst it is a method of improvement best suited to the wrought alloys because of their finer grain size, it is now applied with considerable success to certain cast alloys. In the researches which were made to find further elements which would be of value in heat-treated cast alloys, it was found that the presence of nickel and to a less extent that of iron were advantageous. Nickel increases the solubility of $CuAl_2$ and so tends to shorten the time of heat-treatment and to intensify the results. With iron it forms the complex compounds of Ni-Fe-Al, which raises the melting point of the alloy. The first of the alloys based on these principles is that known as "Y" alloy, which was developed at the National Physical Laboratory in 1920. This alloy, which has the composition:—Cu 3.5 to 4.5 per cent., Ni 1.8 to 2.3 per cent., Mg 1.2 to 1.7 per cent., Si and Fe 0.6 per cent. maximum, immediately enjoyed considerable success as a forged alloy, but for a long time it was considered to be very difficult to cast in sand or even in chills. With improved melting and foundry technique these difficulties have been appreciably reduced, and many castings, particulary those for use at high temperatures, are now produced from this alloy with considerable success. The casting temperature is rather high, and it requires rather heavy runners and risers and plenty of chills to prevent cracking and drawing. As-cast in sand and heat-treated the 0.1 per cent. proof stress is approximately 14 to 15 tons per sq. in., the ultimate stress 15 to 17 tons per sq. in. and the elongation about 1 per cent. In the chill-cast condition the ultimate stress may be 18 to 20 tons per sq. in. and the elongation 1.5 to 3.0 per cent.

During the last few years a new set of alloys, both cast and wrought, marketed under the name of R.R. alloys, has been produced by variations of the original "Y" alloy composition. The essential differences between the new alloys and "Y" alloy are the reduction in the copper and nickel contents, the increase of the iron and silicon contents, the variation of the magnesium content and the introduction of titanium. A noteworthy feature of these mechanical properties is the high ratio of the proof stress to the ultimate stress.

Because of their composition, these alloys have a high liquid shrinkage, but there is a very short temperature interval between the time when they are completely liquid and when they are completely solid. On this account castings must be provided with unusually large runners and risers to ensure sufficient feeding. Their linear casting contraction is low, and, provided the runners and risers are satisfactory, complicated castings can be made with few or no chills.

These alloys are also very free from hot-shortness troubles, and complicated castings can be left in the sand without easing the boxes or breaking down the moulds. An interesting method of testing this property of aluminium alloys has been used by the sponsors of the R.R. alloys in which an H-section was cast between two steel chills, and measurement was made of the clearance required between the chills and the castings to prevent the casting from cracking at the angles. The R.R. alloys are superior in this respect to most of the alloys of aluminium. The alloy R.R.50 is used for general sand castings, as those exhibited to-night, and the die-casting alloy R.R.53 is for use at high temperatures. Considerable use for this alloy has been found for automobile pistons and aero-engine-cylinder heads.

Magnesium Castings.

Probably the greatest innovation in the foundry industry during the past ten years has been the increase in the number of castings made in alloys of magnesium. This metal was first discovered by Davy in 1808, *i.e.*, 16 years before the isolation of aluminium, but because of the difficulty of manufacture it was not produced in appreciable quantities until about 1913. An alloy of magnesium and zinc was used in Germany during the war as a substitute for copper and aluminium alloys, and since that time the use of magnesium alloys has grown rapidly. Until a few weeks ago the only sources of supply

were Germany, where it is produced by the electrolysis of magnesium chloride, and France where it is prepared from magnesium oxide; but arrangements have now been made to manufacture the metal in this country by a new method. The essential value of magnesium is, of course, its low specific gravity, 1.74, for, by virtue of this, considerable saving in weight can be accomplished by the replacement of aluminium castings with magnesium castings. A typical example of this value was the saving of 68 lbs. of dead weight by changing a crankcase casting from aluminium to magnesium. Many such replacements are now being made in the automobile industry, and these changes are made all the easier because no alteration in patterns is necessary.

The original binary alloys of magnesium and zinc have now fallen into disuse, and the modern casting alloys are essentially ternary alloys of magnesium, aluminium and zinc, together with a small percentage of manganese which is added as a preventive against corrosion. Tables II and III show the chemical specification and mechanical properties of the most useful alloys of magnesium.

TABLE II.—*Chemical Composition of Cast Magnesium Alloys.*

Purpose.	Alloy.	Zn.	Al.	Si.	Mn.	Cu.
Sand casting	A Z F	3	4	0–0.3	0.2–0.5	0–0.3
Sand casting	A Z G	3	6	0–0.3	0.2–0.5	0–0.3
General	DTD. 59	3	6	0–0.4	0.2–0.7	0–0.4
General	—	0–1	6–8	0–0.4	0.2–0.7	0–0.4
Chill casting	VI	0–0.6	10	0–0.3	0.2–0.5	0–0.3

TABLE III.—*Mechanical Properties of Cast Magnesium Alloys.*

Alloy.	Condition.	0.1 per cent. proof stress tons/sq. in.	Ult. stress tons sq. in.	E. per cent.	Br.
A Z F	Sand cast	—	9–11	3–4	45–50
	Chill cast	3–4	11–14	6–9	45–60
A Z G	Sand cast	—	9–11	3–5	45–55
	Chill cast	4–5	13–15	6–10	50–60
DTD. 59 ..	Chill cast	6–6.5	12–16	6–12	—
VI	Chill cast	—	12–14	2–4	65–70

It is obvious from these figures that the properties of these alloys compare favourably with those of many aluminium alloys. Within the last few months a further improvement in these properties has been obtained by heat-treating magnesium castings at approximately 400 deg. C. to bring about precipitation hardening. Heat-treated chill-cast test-bars give 15 to 17 tons per sq. ultimate stress with 10 to 15 per cent. elongation. This is noteworthy, because magnesium castings, generally speaking, are sounder than aluminium castings. The machined surfaces are always bright and solid looking, and, because the castings are never broken up by the small gas pockets which break the continuity of aluminium castings, the mechanical properties of magnesium castings are more likely to be of the same order as those of the test-pieces than are the mechanical properties of aluminium castings. As an example, test-pieces cut from a commercial casting after heat-treatment were found to have 13 to 17 tons per sq. ultimate stress and 4 to 12 per cent. elongation.

The founding of magnesium is now-a-days a very much simpler problem than is generally appreciated. This may be due to the fact that the original difficulties have been so successfully overcome that we forget they previously existed. It is difficult to clear from our minds the impression which was formed in boyhood by the burning of magnesium ribbon, and there is a widespread tendency to regard magnesium as a dangerously inflammable material. In actual fact this property of the metal gives so little trouble in the foundry that it can be almost entirely disregarded, and it is common practice to heat the melts to a temperature of 850 deg. C., a temperature which would be ridiculous for aluminium. This is one of the methods employed to free magnesium melts from gases, for in cooling from this temperature to the casting temperature the gases have opportunity to escape, just as they do in the presolidification method which is used for obtaining gas-free melts of aluminium.

The readiness with which magnesium combines with oxygen was originally the greatest difficulty of the magnesium founder. This has been successfully overcome by the use of special fluxes and by the preparation of special moulding sands. The fluxes of which magnesium chloride is the essential constituent are made to have a low melting point. Sufficient is used to completely cover the melt and to form an effective blanket between the magnesium and the oxygen of the atmosphere. It is claimed, in addition, that these fluxes are excellent solvents for all the impurities which are formed by chemical action between the magnesium and the gases from the fuel used for melting. As magnesium is nearly always melted in iron pots, the deterioration from gas penetration through the pots is comparatively small. The second difficulty in magnesium founding was the bad skin on castings produced by ordinary methods of moulding. This was found to be due to the chemical reaction between the molten metal and the residual water in the sand of the mould. This difficulty has been almost completely removed by mixing powdered sulphur and boric acid with the moulding sand, or by blowing into the mould a stream of sulphur dioxide and shaking powdered sulphur on to the surface of the melt during the operation of pouring. The object of both these methods is to cast the metal in a protective blanket of the heavy gas sulphur oxide.

That the application of science to industry has been thoroughly justified is shown by the amazing growth in the production of magnesium castings. The figures showing the growth in tons of magnesium castings made in this country are given in Table IV.

TABLE IV.—*Annual British Production of Magnesium Castings.*

Years.	Tons.
1927	9
1928	29
1929	143
1930	361
1931	420
1932	260
1933 (8 months)	423

These figures are a wonderful lesson of the success which can be achieved by a truly effective working partnership between the chemist, the metallurgist and the foundryman, and joint meetings, such as the one at which this Paper was presented, should be contributory factors to the growth and development of such working partnerships.

MESSRS. HUGHES BOLCHOW, LIMITED, shipbreakers, of Blyth, have purchased for £16,000 the Danish-American liner "Hellig Olav," of 9,939 tons, for breaking-up.

Publication Received.

Aluminium in Architecture and Decoration. Published by the British Aluminium Company, Limited, Adelaide House, King William Street, London, E.C.4.

Foundrymen are prone to grumble that with the coming of mechanised moulding plants, art is being divorced from the industry. To these grumblers we would say: procure a copy of this publication. Not only is it an excellent example of the printer's art, but illustrates in a most striking fashion the potentialities of the light-alloy foundry as a medium for expressing the sculptor's art. It is pleasing to see included a picture of Mr. John Longden's statue of "The Runner." Whilst we have postulated that art castings are removed from mass production, we are reminded in perusing this book that the Rockefeller Centre Building in New York used up 1,340 tons of cast spandrels or 22,000 panels, which surely enters the category of a repetition job. The benefit of this book to foundrymen is that it indicates modern tendencies, shows the range of alloys available and indicates the finishes which it is possible to communicate to aluminium. The officer responsible for this publication can certainly rest assured that every fortunate recipient will look at every page and, finally, will, like the reviewer, take it home for perusal by the family.

Patent Specifications Accepted.

The following list of Patent Specifications accepted has been taken from the "Illustrated Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The last numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

14,171. BRITISH THOMSON-HOUSTON COMPANY, LIMITED. Electric welding machines. 401,208.

15,576. BINDERS INTERNATIONAL COMPANY, LIMITED (Soc. l'Avébene). Foundry moulding sands. 401,217.

17,568. CHAMBON, LIMITED. Devices for adjusting the angular registration of machine units driven from main shafts. 401,231.

28,747. HARTRIDGE, L. Honing or grinding of the bores of cylinders. 400,942.

12,703. BROWNSON, H. W., and IMPERIAL CHEMICAL INDUSTRIES, LIMITED. Manufacture of metal articles. 401,313.

12,704. BROWNSON, H. W., COOK, M., MILLER, H. J., BANNISTER, L. C., and IMPERIAL CHEMICAL INDUSTRIES, LIMITED. Manufacture of metal tubes. 401,314.

14,996. BEDFORD, R. A. Manufacture of hollow drill steel or other hollow bars. 401,381.

18,881. SIMMONDS, C. F., and SHEEPBRIDGE STOKES CENTRIFUGAL CASTINGS COMPANY, LIMITED. Manufacture of piston rings. 401,421.

19,664. DECOCK, J. Metal alloys. 401,431.

20,944. VEREINIGTE STAHLWERKE AKT.-GES. Treatment of ferro-magnetic alloys. 401,443.

23,215. SCHÜLL, F. Manufacture of chains. 401,456.

24,254. ENGLISH STEEL CORPORATION, LIMITED, and CLAYTON, H. E. Locking of dredger bucket pins. 401,462.

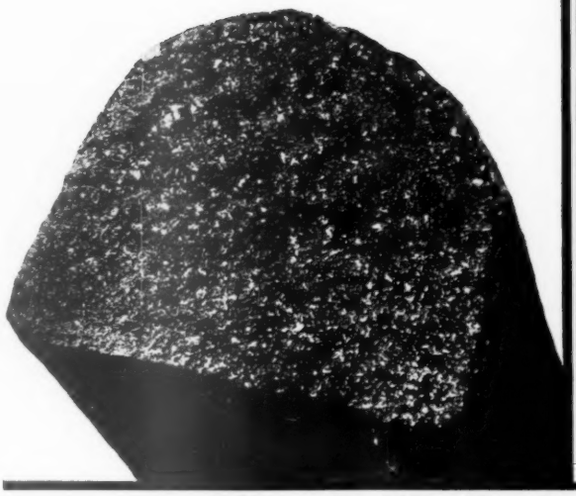
25,043. HUTTO ENGINEERING COMPANY, INC. Grinders for internal cylindrical surfaces. 401,467.

29,713. ZACK, M. Electric arc-welding process for welding aluminium or aluminium alloys. 401,487.

31,962. WILD, L. W., and WILD-BARFIELD ELECTRIC FURNACES, LIMITED. Electric ovens. 401,493.

36,244. INTERNATIONAL PULVERIZING CORPORATION. Pulverising of minerals and similar materials. 401,512.

36,823. AIREY, SIR E. Attaching metal strengthening pieces or ribs to sheet metal or expanded metal. 401,517



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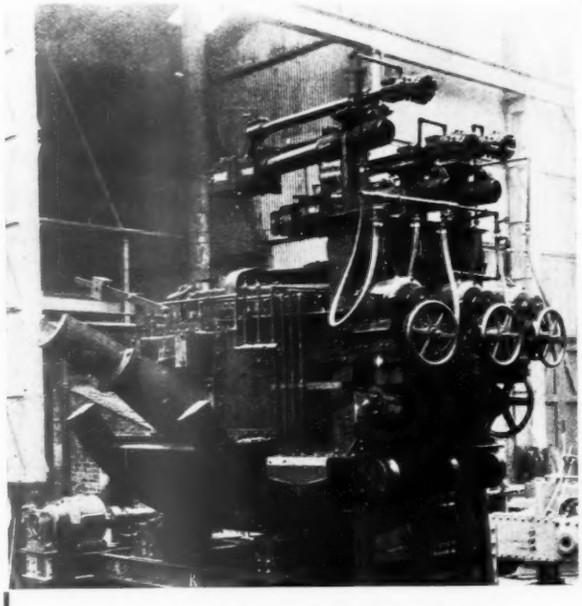

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This Week's News in Brief.

Trade Talk.

NOTICES WERE POSTED up on Tuesday at the Ford Motor Company's works at Dagenham to the effect that:—"Rates of pay will be increased by 1d. as from January 1, 1934." This increase applies, it is understood, to all departments with the exception of the office staff.

MESSRS. AITCHISON BLAIR, LIMITED, Whitecrook Engine Works, Clydebank, have received orders for the construction of two sets of triple-expansion engines for new vessels. The firm enjoys a reputation for marine engines for all classes of vessels, and they have been busily engaged on a design of engine to work with a low fuel consumption, and these new jobs will embody special features with this aim in view.

MESSRS. URQUHART, LINDSAY, ROBERTSON, ORCHAR, LIMITED, Blackness Foundry, Dundee, have booked an order for about £25,000 worth of equipment and machinery for a new sack- and bag-manufacturing mill in Santiago. The order will provide work for many additional workers for several months. Part of the work will be carried out by the associated firm of Messrs. Fairbairn, Lawson, Coombe, Barbour, Limited, Leeds.

IN ORDER TO PROVIDE the necessary space for the extension and development of their spun and cast-iron pipes and general foundry developments, Cochranes (Middlesbrough) Foundry, Limited, Ormesby Ironworks, Middlesbrough, have decided to dismantle the blast-furnace plant, containing in all three blast furnaces with the necessary stoves and auxiliary plant. The space at present occupied by the above plant will enable the present foundry equipment to be extended on up-to-date lines.

THE FOUNDRIES in the Falkirk district closed down for New Year holidays on Friday evening, December 29, which, on account of the briskness of trade now being experienced in the light-castings industry, were of much shorter duration than for a number of years. Whereas last year many of the works closed for a full fortnight and others closed for seven to ten days, the cessation of activities this year will in most cases extend only until January 3, and in no case will resumption be delayed for more than a week.

THE ANNUAL SOCIAL MEETING of the Glenfield Veterans' Club was held in Messrs. Glenfields & Kennedy's dining hall on December 28. Mr. Thomas Robertson, who presided, was supported by Mr. E. Bruce Ball, Wh.Sc., managing director of the firm; Sir Alexander Walker, K.B.E., director; Mr. S. B. Wilson, secretary; Mr. Henry Gardner, works manager; Mr. Bruce Ball, jun.; Mr. P. Cameron, Welfare Supervisor; and Mr. A. F. Ferguson, Edinburgh. About 60 of the veterans were present, and a meal was served by the firm's canteen staff.

THE CLYDESDALE BRANCH of the Iron and Steel Federation had a meeting with the management of Messrs. Stewarts and Lloyds, Limited, and came to an arrangement in regard to the men who are to be retained to work the billet plant at the Clydesdale Steel Works, Mossend. It is estimated that about 180 men will be required out of the 900 at present employed, and the existing wage agreement will be continued. Only two furnaces will be required. Many of the men with long service have been retained, as the feeling is prevalent that the majority of the younger men will find employment at Corby, where the universal mill is being transferred.

DURING THE LAST TWO WEEKS of the year the Grangemouth Docks have been exceptionally busy, all classes of traffic being handled, every berth occupied, and every available docker employed. A pleasing feature is the arrival of large cargoes of iron ore, including one of 5,000 tons from Bilbao and one of 8,500 from the West Coast of Africa. This latter represents a new trade, and the vessel brought the third cargo from the new iron-ore field which is being worked at Sierra Leone; the previous cargoes from this country have been taken to the Clyde. The amount of ore which the vessel took into Grangemouth was the largest that has ever arrived in a Forth port.

MESSRS. BABCOCK & WILCOX, LIMITED, Renfrew, have booked orders valued at over £500,000 during December. Extra men are being taken on, and it is anticipated that by the end of January nearly 800 of the suspended workmen will be restarted at work. The work already in hand will last till nearly the end of 1934, and there is a likelihood of further contracts being obtained in the near future. The contracts are for Britain, South Africa and Japan, and include about a dozen cranes for steelworks in Newcastle and Sheffield, boilers with buildings, stokers and other accessories, two orders for gold mines, and a large boiler for power-station work. The firm have also on hand a large amount of conveyor and welded water-pipe work.

MESSRS. WILSONS & MATHIESONS, LIMITED, of Armley, Leeds, founders and engineers, specialising in gas and sanitary appliances, are in negotiation with two Leeds firms of estate agents with a view to the purchase of the site formerly occupied by the Leeds Forge. The site is of 22 acres, rather more than twice the extent of the existing Wilsons & Mathiesons' works adjacent. The intention is to acquire the land for gradual extensions and developments of Radiation, Limited, with which Wilsons & Mathiesons are associated. The Leeds Forge, established in 1874, at one time employed 2,000 men, but, owing to the post-war slump, the number fell to 300 at the time the works were closed down in 1930, and the place is now being dismantled. The Wilsons & Mathiesons' undertaking was founded in 1854.

FURTHER EVIDENCE of the returning confidence in industry is the announcement made by Messrs. Colvilles, Limited, of their intention to restore a portion of the 10 per cent. cut made three years ago on the salaries of the staff and employees. The New Year gift is one of 5 per cent., and hopes are being entertained that a continuance of the recent spurt in trade will lead to the restoration of the remaining 5 per cent. The decision will affect all staff workers in the company's employment, Glengarnock, Glasgow office, Clydebridge and Motherwell. A 5 per cent. cut imposed on employees of the Steel Company of Scotland has been returned in the shape of a bonus equal to the reduction. Should conditions during the current year warrant restoration of the cut permanently, it is expected that the directors will take that step.

New Companies.

Electro-Metallurgical Research Company, Limited, 150, Southampton Row, London, W.C.1.—Capital, £100.

Bal-Nel Alloys, Limited.—Capital, £1,000. Directors: R. K. Duncan, 80, Upper Shaftesbury Avenue, Southampton; P. Oliphant-Wilson.

Yorkshire Metal Sprayers, Limited.—Capital, £4,000. Directors: P. R. T. Garnett, Wharfeside House, Otley; N. H. Kitchen and A. G. Wilson.

Gilbert Howarth, Limited.—Capital, £1,050. Ironfounders, manufacturers of agricultural implements, etc. Directors: G. Howarth, Gladstone Mill House, Castle Norwich; E. Howarth and J. C. Howarth.

Clifton Ironworks, Limited, 105, Clifton Street, London, S.W.8.—Capital, £200. To take over the business of acetylene welding and general ironworkers, including the manufacture of stainless-steel dairy utensils, carried on by Alfred Burnard, Limited. Directors: E. E. Morris and A. J. Purdue.

Imported Pipe and Tube Fittings.

The Board of Trade give notice that they have referred to the Standing Committee an application for an Order-in-Council to require the marking with an indication of origin of imported fittings of iron or steel for wrought-iron or steel pipes and tubes.

Representatives of any interests substantially affected by the application, who desire to be heard in opposition at the public inquiry which will be held later by the Committee, should communicate with the Secretary, Mr. E. W. Reardon, at the Board of Trade Offices, Great George Street, London, S.W.1, not later than January 27 next.

IMPERIAL CHEMICAL INDUSTRIES, LIMITED, have made an offer to the shareholders of the Broughton Copper Company, Limited, to acquire the whole of the issued share capital of that company, which carries on business as copper smelters and manufacturers, with works at Manchester, Ditton and Garston.

Personal.

SIR GERVAIS RENTOUL, K.C., M.P., Ex-President of the British Ironfounders' Association, has been appointed a Metropolitan Police Magistrate.

MR. AND MRS. JOHN BAIRD have celebrated their golden wedding. Mr. Baird was employed for over 47 years at Abbot's Foundry Company, Falkirk; for the last 27 years of that time he was the works manager, and retired about a year ago.

MR. AND MRS. WILLIAM CRAIG have just celebrated the fiftieth anniversary of their marriage, which took place on December 28, 1883. Mr. Craig, who is 75 years of age, is a native of Falkirk, and was for 52 years a moulder in the Callendar Foundry, Falkirk.

A DEPUTATION FROM THE FOREMEN of Messrs. Glenfield & Kennedy, Limited, Kilmarnock, waited on Mr. William Strathdee at his home on December 28, and presented him with a wallet of notes to mark the occasion of his retirement from the position of foreman of the brass-moulding department. Mr. John Orr, of the brass-finishing department, in making the presentation, commented on Mr. Strathdee's long period of service of 56 years with the firm, and expressed the hope that he would long be spared to enjoy a well-earned leisure.

Wills.

SMITH, JOHN, of Keighley, managing director of the Rustless Iron Company, Limited, Keighley	£36,039
MUMFORD, A. G., of Braiswick, Colchester, founder of the firm of A. G. Mumford, Limited, engineers, of Colchester	£271,065
HALL, HEWITSON, of London, formerly general manager of the blast furnaces and steelworks of Messrs. Palmers Shipbuilding & Iron Company, Limited, Jarrow-on-Tyne	£23,688

Obituary.

MR. WILLIAM MCKINNEL, a director of Messrs. Samuel Osborn & Company, Limited, Clyde Steelworks, Sheffield, died at Axminster, Devon, recently. Mr. McKinnel was 80 years of age and had been a director for upwards of 30 years, starting as a boy with the company.

THE DEATH OCCURRED last week, at his residence, "Janefield," Shankland Road, Greenock, of Mr. Neil M. Brown, managing director of the Lion Iron Foundry, Kirkintilloch, and a former Provost of Greenock. He had three of his sons associated with him in the foundry trade. Mr. Brown was in his 75th year.

THE DEATH OCCURRED, on December 28, after a prolonged illness, at his residence in Denny, of Mr. George B. Paul, senior member and the founder of the firm of Messrs. George Paul & Company, Limited, Duncarron Foundry, Denny. Mr. Paul was over 80 years of age, and had a long and varied experience of the trade, but, due to ill-health, he had been incapacitated to such an extent that for the last ten years he had been able to take little part in the active management of the firm. At the public funeral on Saturday afternoon there was a large attendance of mourners representative of the industry.

THE DEATH, at the age of 63 years, of Mr. Thos. Marshall, head of Thos. Marshall & Son, galvanised tank manufacturers, of Wellington Street, Leeds, removes a figure whose business life was a romance of industry. A native of Stanningley, he began work at nine years of age as a half-timer in a local textile mill. Then he became a labourer at the Stanningley Foundry, and in 1912, after working in various parts of the country and spending his leisure time in self-education, he returned to the Stanningley Foundry as works manager. Fourteen years ago, with his son, he commenced in Leeds in the manufacture of galvanised tanks, and, in spite of a health affliction which largely incapacitated him from getting about, he built up a successful business. Though latterly he had resided at Roundhay, he retained his interest in Stanningley.

IN THEIR standard window factory at Witham, the Crittall Manufacturing Company, Limited, have been making for some months past between 6,000 and 7,000 windows daily. They are engaged on a scheme of production which will enable them to increase the output to 10,000 windows daily.

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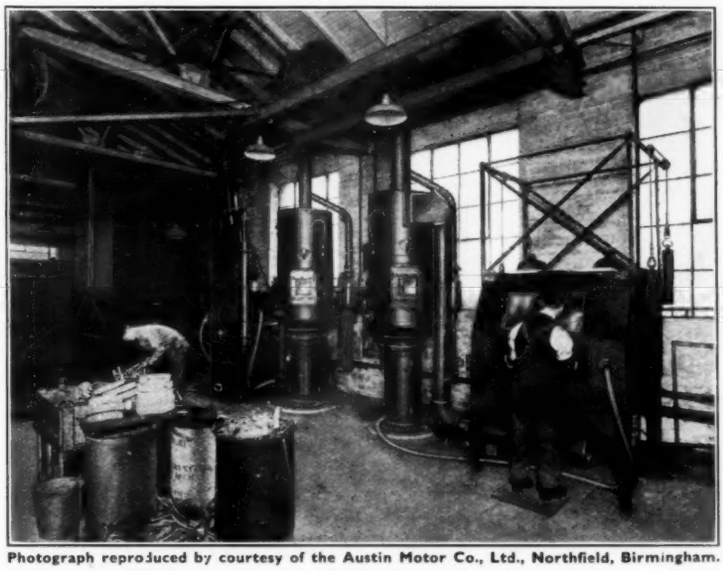

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Raw Material Markets.

Traders in iron and steel have entered upon 1934 with decided optimism, and markets generally have shown buoyant tendencies. The demand for iron remains at a much improved level, and in some districts there are signs of an approaching shortage of supplies, particularly on the North-East Coast, where quantities of Midlands iron have had to be brought in. Production is to be increased shortly, but the possibility of higher prices remains strong, especially in view of the comparative scarcity of furnace coke.

Pig-Iron.

MIDDLESBROUGH.—The outlook in the Cleveland foundry-iron trade is very promising. Deliveries to consumers last month reached a high level, which would have been higher still if further supplies had been available. At the present moment there is a considerable unsatisfied demand, and it has for some time been obvious that an increase in production would have to be made. The chief factor holding up increased output at the moment is the scarcity of coke. However, the situation should be partly remedied when a furnace is relit at Skinningrove. It is stated that this will take place shortly. Little or nothing is now left of the once heavy stocks held by the ironworks. The fixed minima for No. 3 Cleveland G.M.B. quality for home sales are:—Delivered Middlesbrough, 62s. 6d.; delivered North-East Coast, 64s. 6d.; delivered Falkirk, 62s. 3d.; delivered Glasgow, 65s. 3d. per ton. No. 1 foundry iron is 2s. 6d. per ton more than No. 3, whilst No. 4 foundry and No. 4 forge grades are 1s. less.

The continued reduction of the makers' stocks of East Coast hematite, which were heavily drawn upon last month to make up deliveries, gives strength to the rumours of an impending increase in the price, as the output of the six furnaces at present working falls well below the current demand. Some consumers have endeavoured to place twelve-months' contracts at the present price levels, but the makers are holding back; they have already sold most of their output for the first quarter of the year. There are few sellers at the present official price, which is 62s. 6d. per ton f.o.t. for mixed numbers.

LANCASHIRE.—Some sections of the iron-consuming industries in this area have found themselves in a sufficiently strong position, as far as orders are concerned, to enter into contracts for pig-iron supplies over the next three months. Market quotations are distinctly firm. For delivery to users in the Manchester zone, Staffordshire, Derbyshire and North-East Coast brands of No. 3 iron are all quoted on the basis of 67s. per ton, with Northants at 65s. 6d., Derbyshire forge iron at 62s. and Scottish foundry at from 79s. to 80s. per ton.

MIDLANDS.—The light-castings foundries in this area remain exceptionally busy, but this is offset to a certain extent by the slack conditions at the engineering works. Prices have not been changed, the minimum figures for Birmingham and Black Country stations being 62s. 6d. for Northants No. 3 and 66s. for Derbyshire, Lincolnshire and North Staffordshire No. 3, with 7d. per ton extra for delivery into consumers' works. As indicated previously, little new business is forthcoming, because of the fact that most consumers are covered for some months ahead under contract. There is a slightly increased demand for iron of a special character for engineering and motor work. Refined irons are offered at between £5 15s. and £6 15s. per ton, medium-phosphorus iron from 70s. to 80s., and low phosphorus from 80s. to 90s. Scottish No. 3 iron is available at 85s. per ton delivered Midland points.

SCOTLAND.—The holiday stoppage has in some cases not been so long as usual, as many firms remain exceptionally busy, particularly in the Falkirk area. Some moderate forward buying of foundry iron has taken place. Scottish No. 3 foundry remains at 65s. f.o.t. furnaces, with 2s. 6d. extra for No. 1. No. 3 Middlesbrough is at 62s. 3d. f.o.t. Falkirk and 65s. 3d. f.o.t. Glasgow, and in strong demand, as are other English irons at 1s. 3d. per ton below Cleveland prices.

Coke.

Prices of Durham foundry coke in South Staffordshire have remained unaltered, although Welsh coke is already dearer. The latter is now quoted at 32s. to 45s. per ton, according to tonnage and analysis; best Durham coke is 36s. to 38s., with cheaper grades at about 34s. to 35s., and Scottish special low-ash coke at 38s. 6d. to 39s.; all delivered at Black Country stations.

Steel.

Business has scarcely settled down after the holiday interruption, but as many of the works closed down for much shorter periods than usual, deliveries were resumed early on a good scale, says the official report of the London Iron and Steel Exchange. The British works producing semi-finished steel are busily employed, and there is pressure from some consumers to accelerate delivery. A certain amount of business continues to be transacted in Continental semi-finished material, but the quantities sold to the British market are comparatively small. Prices of British and Continental material are firm and have a tendency to advance. In the finished-steel section business revived quickly after the holidays. There has been a considerable amount of inquiry from oversea, and the home market also is again becoming busy. In this department some competition is being experienced from Continental steel, some descriptions of which, delivered and including duty, are quoted at well below the British makers' quotations.

Scrap.

There continues to be a strong demand for scrap in the Cleveland area. Little heavy metal is on offer, ordinary metal being sold at about 51s. and machinery at 53s. Up to 49s. is asked for light metal. There continues to be a steady demand for cast-iron scrap in the Midlands, heavy machinery being at 52s. 6d. to 55s., heavy pipe and plate scrap at 47s. 6d. to 50s., and clean light metal at 42s. 6d., all delivered works. The demand for scrap iron in South Wales is still slow, prices remaining unchanged. In Scotland, machinery scrap is in better demand at about 52s. 6d. per ton, ordinary cast iron remaining at 47s. 6d. to 48s. 6d., with light metal still at 43s. 6d. per ton.

Metals.

Copper.—Although trading in this metal has recently been slow, owing to holiday conditions, the market maintained a firm tone, and entered the New Year with a feeling of optimism. Trade demand is not very large at the moment, but, should the improvement noted in the consuming industries in the second half of 1933 be continued, higher prices may well be seen within a short period.

It is reported that the situation in the German brass-manufacturing industry is much improved. Many of the works have good orders in hand, and have covered their requirements of copper accordingly. Imports of copper into Germany during the first eleven months of 1933 showed a considerable increase as compared with the same period of 1932.

The week's prices have been as follow :—

Cash.—Thursday, £32 7s. 6d. to £32 10s.; Friday, £32 10s. to £32 12s. 6d.; Tuesday, £32 3s. 9d. to £32 5s.; Wednesday, £32 2s. 6d. to £32 3s. 9d.

Three Months. — Thursday, £32 10s. to £32 12s. 6d.; Friday, £32 13s. 9d. to £32 15s.; Tuesday, £32 6s. 3d. to £32 7s. 6d.; Wednesday, £32 5s. to £32 6s. 3d.

Tin.—Trading has been limited by holiday conditions and seasonal stock-taking operations, but the outlook for this month's trading remains fairly good. The "total visible supply" of tin was estimated to have fallen during December by roughly 2,000 tons to about 23,000 tons.

This month, however, sees the commencement of an increase in exports from the mines. National export quotas are increased from 33⅓ per cent. to 40 per cent. of the standard tonnages; in addition, there is to be a special quota of 4 per cent. during 1934, from which excess exports made last year are to be deducted. It is likely that a period of comparative stability in prices will be seen.

Daily quotations :—

Cash.—Thursday, £227 5s. to £227 10s.; Friday, £227 15s. to £227 17s. 6d.; Tuesday, £227 2s. 6d. to £227 5s.; Wednesday, £226 17s. 6d. to £227.

Three Months. — Thursday, £227 10s. to £227 12s. 6d.; Friday, £227 17s. 6d. to £228; Tuesday, £227 10s. to £227 12s. 6d.; Wednesday, £227 2s. 6d. to £227 5s.

Spelter.—Business has been slack in spelter, but holders have shown no inclination to press sales, and the market has maintained a firm tone. The consumption of this metal has been favourably affected by the increased activity at brass works, not only in this country but also on the Continent. Galvanised-sheet manufacturers are still in an unsatisfactory position, particularly as regards export orders.

Price fluctuations :—

Ordinary. — Thursday, £14 16s. 3d.; Friday, £14 17s. 6d.; Tuesday, £14 12s. 6d.; Wednesday, £14 7s. 6d.

Lead.—The lead market has recently shown a certain lack of animation. This can partly be ascribed to holiday conditions, but it is also largely due to the effect of the announcement regarding American lead stocks. The latter showed an increase of 13,000 tons during November as compared with the previous month. Consumption of lead has not been very heavy on this side of the Atlantic either, but should improve if the present upward tendency in general industrial activity is maintained.

Daily market prices :—

Soft Foreign (Prompt).—Thursday, £11 2s. 6d.; Friday, £11 5s.; Tuesday, £11 1s. 3d.; Wednesday, £10 17s. 6d.

Continental Steel Cartel.

The Continental Steel Cartel has decided to continue for the ensuing quarter the monthly export quota at 500,000 metric tons. The committee for the sales organisation is to meet at Brussels to-day (January 4), when the question of increasing the prices of semis and some finished products for the British market will probably be discussed. The failure to form a syndicate for thin sheets is ascribed to the large quotas demanded by the Belgian works and to the refusal of British works to join.

Stainless-Steel Barrels.—One of the largest stainless-steel orders on record, states "The Iron Age," has been placed with Republic Steel Corporation, Ohio, by the Firestone Steel Products Company, Akron, Ohio. The steel is to be used in the fabrication of the Firestone insulated stainless-steel beer barrel. The barrel is of double-walled construction with a lining of Enduro stainless steel insulated by dead air space from the outer shell, which is ruggedly built of plain steel. The use of stainless steel for the lining of the barrel obviates the necessity of pitching and eliminates cooperage.

Falkirk Industrial Improvement.—Operation of a standardised price level in certain sections of the light-castings industry has produced excellent results. Due to products fetching a fair price in the market, foundry concerns have completed the most satisfactory year's trading for a long time. During the last six months a boom has been experienced in the Falkirk area, and hundreds of unemployed men found work in the various foundries which have been at capacity output for the first time for years. Efforts to rid the industry of cut-throat competition have partly succeeded, and in May an important agreement was reached between merchants and manufacturers in respect of fitted goods, and this had a desirable effect on the stabilisation of prices in that particular section of the industry. An important development affecting the baths section of the light-castings industry, which is of vital concern to Falkirk, was the formation of an international Baths Association as the outcome of prolonged negotiations. This has had the effect of stabilising prices in the home market and controlling imports from the Continent. The output of baths in the Falkirk area has greatly increased, and not for a very long time has such a demand existed. Although so far no outstanding progress has been made in regard to export trade, the founders are seriously considering a scheme for the assistance of this branch of the trade. The outlook for 1934 is decidedly encouraging, and the general opinion is that full-capacity working will obtain for at least the first three months of the year. The State benefit paid to idle members of the Ironfounding Workers' Association for the last week of 1933 was £230, or about one-ninth that paid during the last week of 1932, and this may be taken as an indication of the improvement in the light-castings industry.

GENUINE COLD BLAST PIG IRON

In addition to their renowned chilling properties, and their resistance to wear and to growth under heat, our COLD BLAST PIG IRONS are noted for their

GREAT STRENGTH *and* TOUGHNESS

Our Cold Blast Pigirons are Genuine All-mine Blast Furnace Products.

YOUR CASTINGS WILL BE ALL THE STRONGER AND SOUNDER FOR THE INCLUSION OF SOME GENUINE COLD BLAST PIG IRON IN YOUR MIXTURE.

THE EARL OF DUDLEY'S ROUND OAK WORKS, LTD.,
BRIERLEY HILL, STAFFS.
Brand: "DUD·L.N.F'ces·DUD"

M. & W. GRAZEBROOK,
LIMITED,
DUDLEY, WORCS.
Brand: "GRAZEBROOK"

THE LOW MOOR IRON
CO., LTD.,
NEW WORKS, LOW MOOR
BRADFORD - YORKSHIRE.
Brand: "LOWMOOR C.B."

MAKERS OF GENUINE COLD BLAST PIG IRON

RAW MATERIALS—PRICE LIST.

(Wednesday, January 3, 1934.)

COPPER.

	£	s.	d.
Standard cash	32	2	6
Three months	32	5	0
Electrolytic	35	10	0
Tough	34	5	0
Best selected	34	15	0
Sheets	62	0	0
India	44	10	0
Wire bars	36	0	0
Ingot bars	36	0	0
H.C. wire rods	39	5	0
Off. av. cash, December	31	6	11 13/42
Do., 3 mths., December	31	9	5 13/42
Do., Sttlmnt., December	31	6	11 13/42
Do., Electro, December	34	14	2 21/42
Do., B.S., December	34	1	11 1/3
Do., wire bars, December	35	1	10 21/42
Solid drawn tubes			10d.
Brazed tubes			10d.
Wire			6½d.

BRASS.

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	8¾d.
Rods, extd. or rlld.	4½d.
Sheets to 10 w.g.	7⅝d.
Wire	7⅝d.
Rolled metal	7d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5¾d.
Do. 4 × 3 Sheets	5¾d.

TIN.

	£	s.	d.
Standard cash	226	17	6
Three months	227	2	6
English	227	10	0
Bars	228	15	0
Straits	232	0	0
Australian (nom.)	—		
Eastern	231	0	0
Banca	231	12	6
Off. av. cash, December	227	14	10 5/42
Do., 3 mths., December	227	15	7 17/42
Do., Sttlmt., December	227	14	5 13/42

SPELTER.

	£	s.	d.
Ordinary	14	7	6
Remelted	14	0	0
Hard	12	0	0
Electro 99.9	16	10	0
English	15	2	6
India	14	0	0
Zinc dust	20	0	0
Zinc ashes	3	5	0
Off. aver., December	14	16	6 3/42
Aver. spot, December	14	18	10 5/42

LEAD.

	£	s.	d.
Soft foreign ppt.	10	17	6
Empire	11	6	3
English	12	5	0
Off. average, December	11	8	7 7/42
Average spot, December	11	10	10 5/42

ALUMINIUM.

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	10	0
Do., V.M. ex whse.	23	5	0
Rods	28	15	0

ANTIMONY.

	£	s.	d.
English	37 10 0 to 40	0	0
Chinese, ex-whse.	26	10	0
Crude	20	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	9	2	6 to 9 12 6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£6 10 0
45/50%	£12 10 0
75%	£18 2 6
Ferro-vanadium—	
35 50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	5/6 per lb. of Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£14 10 0
Ferro-tungsten—	
80/85%	2/6 lb.
Tungsten metal powder—	
98/99%	2/9 lb.
Ferro-chrome—	
2/4% car.	£32 0 0
4/6% car.	£23 0 0
6/8% car.	£21 12 6
8/10% car.	£21 12 6
Ferro-chrome—	
Max. 2% car.	£34 10 0
Max. 1% car.	£35 12 6
Max. 0.70% car.	£37 10 0
70%, carbon-free	10½d. lb.
Nickel—99.5/100%	£225 to £230
"F" nickel shot	£202 10 0
Ferro-cobalt, 98/99%	5/- lb.
Metallic chromium—	
96/98%	2/8 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/2 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ⅛ in.	3d. lb.
Do., under ⅛ in. to 1/16 in.	1/- lb.
Flats, ½ in. × ⅛ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ⅛ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel				2	10	0
Bundled steel and shrngs.	2	2	6 to	2	10	0
Mixed iron and steel	2	5	0 to	2	6	0
Heavy cast iron				2	5	0
Good machinery	2	7	6 to	2	10	0
Cleveland—						
Heavy steel	2	10	0 to	2	14	0
Steel turnings				1	15	0
Cast-iron borings				1	5	0
Heavy forge				2	10	0
W.I. piling scrap				2	5	0
Cast-iron scrap	2	11	0 to	2	13	0
Midlands—						
Light cast-iron scrap				2	2	6
Heavy wrought iron				2	15	0
Steel turnings, f.o.r.				1	10	0
Scotland—						
Heavy steel	2	7	6 to	2	10	0
Ordinary cast iron	2	7	6 to	2	8	6
Engineers' turnings				1	17	6
Cast-iron borings				1	17	6
Wrought-iron piling				2	11	0
Heavy machinery				2	12	6

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	26	0	0
Brass	19	10	0
Lead (less usual draft)	10	10	0
Tea lead	7	10	0
Zinc	9	10	0
New aluminium cuttings	70	0	0
Braziery copper	24	0	0
Gunmetal	24	0	0
Hollow pewter	150	0	0
Shaped black pewter	106	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast (d/d Tees side area)—	
Foundry No. 1	65/-
Foundry No. 3	62/6
,, at Falkirk	62/3
,, at Glasgow	65/3
Foundry No. 4	61/6
Forge No. 4	61/6
Hematite No. 1, f.o.t.	63/-
Hematite M/Nos., f.o.t.	62/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	69/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	62/-
,, No. 3 fdry.	66/-
Northants forge	58/6
,, fdry. No. 3	62/6
,, fdry. No. 1	65/6
Derbyshire forge	62/-
,, fdry. No. 3	66/-
,, fdry. No. 1	69/-
Scotland—	
Foundry No. 1	67 6
,, No. 3	65/-
Hem. M/Nos. d/d	66/-
Sheffield (d/d district)—	
Derby forge	59/6
,, fdry. No. 3	63/6
Lincs forge	59/6
,, fdry. No. 3	63/6
E.C. hematite	76/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	80/-
Clyde, No. 3	80/-
Monkland, No. 3	80/-
Summerlee, No. 3	80/-
Eglinton, No. 3	80/-
Gartsherrie, No. 3	80/-
Shotts, No. 3	80/-

FINISHED IRON AND STEEL.

Usual district deliveries for iron; delivered consumer's station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars (cr.)	9	0	0 to	9	15	0
Nut and bolt iron	6	17	6 to	7	10	0
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.	13	15	0			
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	8	5	0 to	8	10	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ⅜ in. (Untested)				7	12	6 & up.
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)	10	10	0 & up.			
Black sheets, 24g. (4-t. lots)				10	5	0
Galv. cor. shts. (,,)				12	15	0
Galv. flat shts. (,,)				13	5	0
Galv. fencing wire, 8g. plain				14	0	0
Billets, soft	5	10	0 to	5	15	0
Billets, hard	6	17	6 to	7	2	6
Sheet bars	5	0	0 to	5	10	0
Tin bars				5	0	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	11d.
Sheet to 10 w.g.	12d.
Wire	12d.
Rods	11d.
Tubes	15d.
Castings	13d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	19.26
No. 2 foundry, Valley	17.50
No. 2 foundry, Birm.	13.50
Basic	18.89
Bessemer	19.76
Malleable	19.39
Grey forge	19.39
Ferro-mang. 80%, seaboard	82.00
O.-h. rails, h'y, at mill	36.37½
Billets	26.00
Sheet bars	26.00
Wire rods	36.00
	Cents.
Iron bars, Phila.	1.89
Steel bars	1.75
Tank plates	1.79
Beams, etc.	1.70
Skelp, grooved steel	1.60
Steel hoops	1.85
Sheets, black, No. 24	2.25
Sheets, galv., No. 24	2.85
Wire nails	2.35
Plain wire	2.20
Barbed wire, galv.	2.85
Tinplates, 100-lb. box	$5.25

COKE (at ovens).

Welsh foundry	20/- to 27/6
,, furnace	17/6 to 18/-
Durham foundry	21/- to 25/-
,, furnace	16/-
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	16/3 to 16/6
,,	28×20 ,,	32/6 to 33/-
,,	20×10 ,,	24/-
,,	18¾×14 ,,	17/-
C.W.	20×14 ,,	15/-
,,	28×20 ,,	31/9
,,	20×10 ,,	23/-
,,	18¾×14 ,,	15/6

SWEDISH CHARCOAL IRON & STEEL.

	£	s.	d.	£	s.	d.
Pig-iron	6	0	0 to	7	0	0
Bars-hammered, basis	16	0	0 to	16	10	0
Bars and nail-rods, rolled, basis	15	15	0 to	16	0	0
Blooms	10	0	0 to	12	0	0
Keg steel	30	0	0 to	31	0	0
Faggot steel	18	0	0 to	23	0	0
Bars and rods dead soft, st'l	10	0	0 to	12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

			£	s.	d.	
Dec.	28	..	32	7	6 inc.	3/9
,,	29	..	32	10	0 ,,	2/6
Jan.	2	..	32	3	9 dec.	6/3
,,	3	..	32	2	6 ,,	1/3

Electrolytic Copper.

			£	s.	d.	
Dec.	28	..	35	15	0 inc.	5/-
,,	29	..	36	0	0 ,,	5/-
Jan.	2	..	35	10	0 dec.	10/-
,,	3	..	35	10	0 No change	

Standard Tin (cash).

			£	s.	d.		
Dec.	28	..	227	5	0	dec.	15/-
,,	29	..	227	15	0	inc.	10/-
Jan.	2	..	227	2	6	dec.	12/6
,,	3	..	226	17	6	,,	5/-

Tin (English ingots).

			£	s.	d.		
Dec.	28	..	227	15	0	dec.	15/-
,,	29	..	228	5	0	inc.	10/-
Jan.	2	..	227	15	0	dec.	10/-
,,	3	..	227	10	0	,,	5/-

Spelter (ordinary).

			£	s.	d.		
Dec.	28	..	14	16	3	inc.	1/3
,,	29	..	14	17	6	,,	1/3
Jan.	2	..	14	12	6	dec.	5/-
,,	3	..	14	7	6	,,	5/-

Spelter (Electro, 99.9 per cent.).

			£	s.	d.		
Dec.	28	..	17	2	6	inc.	2/6
,,	29	..	17	0	0	dec.	2/6
Jan.	2	..	16	15	0	,,	5/-
,,	3	..	16	10	0	,,	5/-

Zinc Sheets (English).

			£	s.	d.		
Dec.	28	..	24	10	0	dec.	20/-
,,	29	..	24	10	0	No change	
Jan.	2	..	24	10	0	,,	,,
,,	3	..	24	10	0	,,	,,

Lead (English).

			£	s.	d.		
Dec.	28	..	12	10	0	dec.	5/-
,,	29	..	12	10	0	No change	
Jan.	2	..	12	10	0	,,	,,
,,	3	..	12	5	0	dec.	5/-

AVERAGE MONTHLY PRICES OF MARKED BARS (SOUTH STAFFS).

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1899	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 10 0	9 0 0	9 0 0	9 10 0	10 0 0	10 0 0	10 0 0	8 3 4
1900	11 0 0	11 10 0	11 10 0	11 10 0	11 16 0	1 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 5 10
1901	9 10 0	9 10 0	9 10 0	9 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 16 8
1902	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 7 6
1903	8 5 0	8 5 0	8 5 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 8 9
1904	8 10 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 10
1905	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 10 0	8 1 8
1906	8 10 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	8 10 0	8 10 0	8 10 0	8 10 0	9 0 0	8 15 10
1907	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0
1908	9 0 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 5 10
1909	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1910	8 0 0	8 0 0	8 0 0	8 0 9	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1911	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1912	8 10 0	8 10 0	8 10 0	8 15 0	9 0 0	9 0 0	9 0 0	9 8 0	9 10 0	9 10 0	9 10 0	9 15 0	9 1 6
1913	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	9 10 0	9 10 0	9 4 0	9 0 0	9 0 0	9 13 8
1914	8 12 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	8 14 4
1915	9 0 0	9 0 0	9 3 0	10 2 0	10 15 0	11 10 0	12 0 0	12 0 0	12 0 0	12 7 6	12 10 0	13 10 0	11 5 0
1916	13 10 0	13 10 0	14 13 0	15 0 0	15 0 0	15 0 0	15 0 0	15 10 0	15 10 0	15 0 0	15 10 0	15 0 0	14 18 7
1917	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0
1918	15 12 6	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	17 0 0	17 0 0	17 0 0	16 6 3
1919	18 0 0	18 10 0	20 0 0	20 0 0	23 0 0	23 0 0	23 0 0	24 12 0	25 0 0	25 0 0	25 0 0	25 5 0	22 19 7
1920	26 17 6	27 0 0	28 0 0	30 5 0	30 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	31 10 2
1921	31 10 0	30 3 4	27 10 0	27 10 0	27 10 0	24 15 0	21 0 0	20 0 0	20 0 0	17 10 0	17 0 0	16 0 0	23 7 4
1922	16 0 0	14 17 6	14 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 18 1½
1923	13 10 0	13 10 0	13 16 0	14 7 6	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 5 3½
1924	14 10 0	14 10 0	14 10 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 17 6	14 17 3½
1925	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 0 0	14 13 4
1926	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	*	14 10 0	14 0 10
1927	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 0 0	13 0 0	12 18 0	13 15 8
1928	12 10 0	12 10 0	12 10 0	12 2 6	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 2 6½
1929	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 7 6	12 10 0	12 10 0	12 2 3½
1930	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 15 0
1931	12 10 0	12 10 0	12 10 0	12 8 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 3 2
1932	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0
1933	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0

* No quotation available.

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Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

YOUNG Foundry Foreman requires position. Experience on textile machinery, machine-tool and engine work; jobbing and repetition. Experience in cupola control, mixtures and sand control. (235)

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THE Proprietors of British Patent No. 337,715, for the Production of Titanium Steel, are desirous of entering into negotiations with one or more firms in Great Britain for the purpose of exploiting the above invention either by the sale of the patent rights or by the grant of a licence or licences to manufacture on royalty.—Inquiries should be addressed to MESSRS. ABEL & IMRAY, 30, Southampton Buildings, London, W.C.2.

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TENDER.

ARMY CONTRACTS.

NOTICE is hereby given that Tenders for Goods and Services of the kinds mentioned below are invited from time to time, as required :—

Metal Trades.

Aluminium ingot and castings, Brass, Brass rod and sheet, Bronze stampings, Copper ingot and sheet, Lead pig and sheet, Metal rod, Nickel, Pig-iron, Steel plate, rounds, sheets, etc., Tin ingot, Tinplates, Tinned brass pressings and stampings, Zinc ingot and sheets.

Baths, Bicycles, Building materials and fitments, Cutlery (including safety razors and blades), Enamelled-ware, Forge-fittings, Hollow-ware, Horseshoes, Ironmongery, Machinery, Reinforcing metal, Stable fitments, Steel and cast-iron pipes, Stoves and ovens, Tinware (including canisters, etc., to precise dimensions), Tools, Tubular scaffolding, Vehicles, Wire, Wire rope.

Electrical and Scientific Instrument Trades.

Cables, Electrical plant, Electrical and wireless stores, Scientific instruments.

Textile Trades.

Blankets and rugs, Braid and lace, Canvas and canvas goods, Clothing (made up from the Department's own materials), Cotton piece goods and cotton goods, Cordage, Flannel (Union), Head-dresses, Horse rugs, Hosiery, Linen piece goods, Silk cloth and webbing and sewing silk, Towels, Woollen cloths.

Foodstuffs, Coal and Coke.

Other Trades.

Badges and buttons, Basket-ware, Bedding, Boots and shoes, Brooms and brushes, Chemicals and oxygen and acetylene gas, China and earthenware, Furniture, Glazed-ware drain pipes, Harness and saddlery, Leather and leather goods, Linoleum, Medical supplies, Moulded rubber articles, Oil-dressed clothing, Oils and spirits, Paints and varnishes, Rubber boots and clothing, Safety glass, Sanitary appliances, Timber, Woodware.

Building Works, etc.

Jobbing, painting and repair work (including term contracts), New buildings, Heating and electrical installations, Erection of constructional steelwork, Reinforced concrete work, Road and drainage work, Roofing and flooring work, Construction of sports grounds, etc.

Firms who are not already on the War Office List of Tenderers, and who wish to be invited to tender for the above Army requirements as they arise, should apply in writing to THE DIRECTOR OF ARMY CONTRACTS, Caxton House (West), Tothill Street, Westminster, London, S.W.1, for Form 1 (Form 1A in respect of the services mentioned under Building Works above), on which formal application for in-

Continued in next Column.

TENDER—*Continued.*

Continued from previous Column.

clusion on the list of tenderers may be made. The services of an intermediary are unnecessary in approaching the Department for this purpose.

Before being placed on the lists of tenderers, firms will have to satisfy the Department that they actually manufacture goods or carry out services for which they wish to be noted, and will be required to furnish the names of at least two well-known firms or public bodies who have employed or purchased from them and are in a position to certify as to the quality of their work. They will further have to give an undertaking that they will comply with the Fair Wages Resolution of the House of Commons.

Attention is called to the following resolution passed by both Houses of Parliament on February 16, 1926 :—

"That, in the opinion of this House, it is the duty of the Government in all Government contracts to make provision for the employment to the fullest possible extent of disabled ex-Service men, and to this end to confine such contracts, save in exceptional circumstances, to employers enrolled on the King's National Roll."

Sales.

From time to time the Department has for sale surplus Army Stores of various descriptions, among which may be mentioned Machinery, Scrap metals, Hutting, Motor vehicles and spare parts, Medical and dental stores, Veterinary stores, Optical and scientific instruments, Electrical and wireless stores, Clothing, Boots, Textile goods, Explosives and chemicals (including drugs, ammonium nitrate and sodium picrate).

Firms who wish to be invited to tender for the purchase of surplus stores should apply in writing to THE DIRECTOR OF ARMY CONTRACTS, Caxton House (West), Tothill Street, Westminster, London, S.W.1.

Sales of surplus stores by auction are also held at the Royal Arsenal, Woolwich, about the middle of January, March, May, July, September and November. Catalogues may be obtained from the Chief Ordnance Officer, Royal Arsenal, Woolwich, S.E.18.

No application is necessary from firms whose names are already on the War Office Lists, unless they have extended the range of their manufactures.

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'Phone: 287 SLOUGH

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